Eligibility of work in SR&ED projects containing software development

Covering software in Information and Communications Technology (ICT) and other sectors

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Objectives of the webinar

- Examine the eligibility of work that incorporate software development for SR&ED through practical examples
- Provide a common understanding of SR&ED in the context of software development

Webinar outline

- Key aspects of the definition of SR&ED and the methodology used in determining eligibility of work
- Software development in SR&ED claims
- Technology and software development
- Some potential areas of advancements
- Key SR&ED concepts explained through software development examples

The Definition of SR&ED

Identifies

How

"…**systematic investigation or search** carried out in a field of **science** or **technology** by means of **experiment or analysis**…" *and*

Why

"for the **advancement of scientific knowledge** (basic or applied research) or **technological advancement** (experimental development)"

Methodology to determine if work meets the definition of SR&ED

2-step methodology is used to determine if and to what extent work meets the definition of SR&ED:

Step 1 – Determine if there is SR&ED

Step 2 – Determine the extent of eligible work
(only if there is SR&ED)

Step 1: Determine if there is SR&ED

The method to establish if there is SR&ED involves answering five questions.

1. *Was there a scientific or a technological uncertainty?*
2. *Did the effort involve formulating hypotheses specifically aimed at reducing or eliminating that uncertainty?*
3. *Was the overall approach adopted consistent with a systematic investigation or search, including formulating and testing the hypotheses by experiment or analysis?*
4. *Was the overall approach for the purpose of achieving a scientific or a technological advancement?*
5. *Was a record of the hypotheses tested and the results kept as the work progressed?*

Software development in projects

Projects where the software itself is the new or improved product, process or device

- Voice codec software like G 729 codec is a software product containing a particular implementation of a compression algorithm for voice data.
- Web information system and document management tools are software products that allow document management, storage, and publishing on the web.
- Protein structure prediction software for predicting three-dimensional structure model of protein molecules from amino acid sequences is a software product.

Software development in projects (cont'd)

Projects where new or improved product, process, or device is a combination of hardware and software

- Electric drive controllers can be a hardware product with embedded software incorporating both power electronics and microprocessors to exercise dynamic control over speed, torque, and efficiency.

- Bank cheque reading systems based on convolutional Neural Network software can consist of mechanical and electrical hardware to automatically scan and process cheques.

Software development in projects (cont'd)

Projects where software development is necessary but the developed software is not a part of the product, process, or device.

- Example 1: The development of code in Hardware Description Language (HDL) for Application Specific Integrated Circuit (ASIC) using tools such as Verilog/VHDL simulators and HDL Synthesis tools.
- Example 2: Software development necessary solely for testing or conducting experiments using packet sniffing tools with scripting capability.

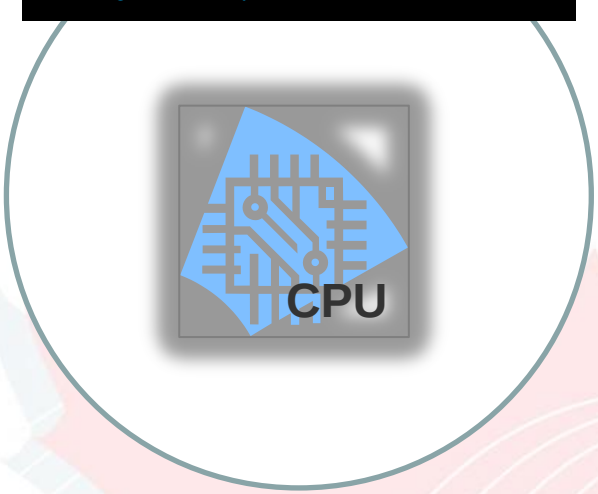
Technology

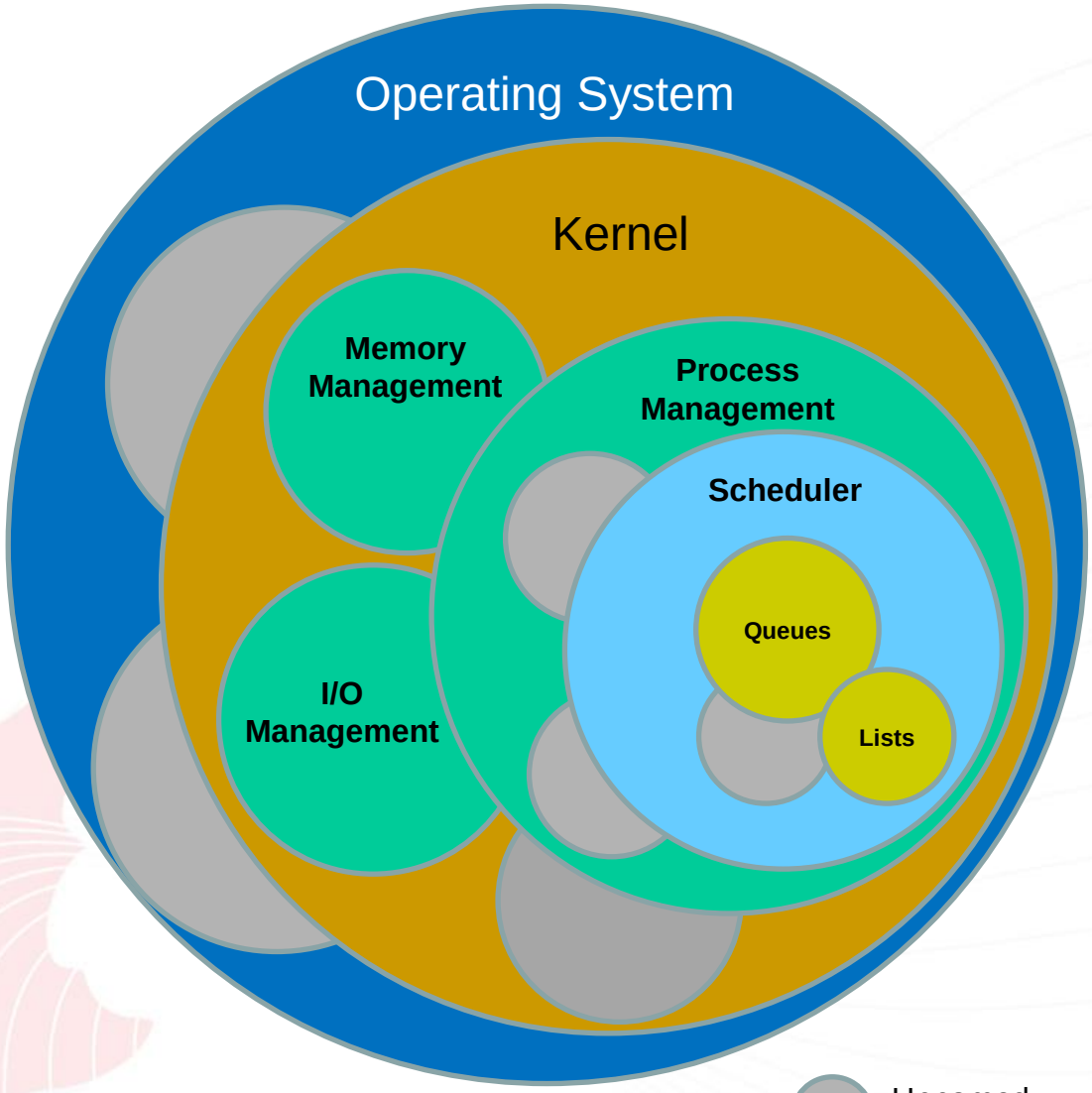
- Technology is not a physical entity.
- Technology is the practical application of scientific knowledge and principles.
- It is the knowledge of how scientifically determined facts and principles are embodied in the material, device, product, or process.

Technology – Example 1

```
0000: AB 22 EE FF AD DA B0 28
000A: CD DD A0 B0 DD 1F CF 35
000B: 4C CC EF 3F 3E 00 00 20
000B: 33 31 00

HELLO THERE!
```





Unnamed Embodiments

Technology – Example 2

Tool

Open Source Electronic Prototyping Platform

UI

Programming Languages | Compiler | Linker

```
0000: AB 22 EE FF AD DA B0 28
000A: CD DD A0 B0 DD 1F CF 35
000B: 4C CC EF 3F 3E 00 00 20
000B: 33 31 00

HELLO THERE!
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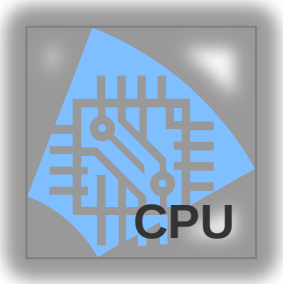
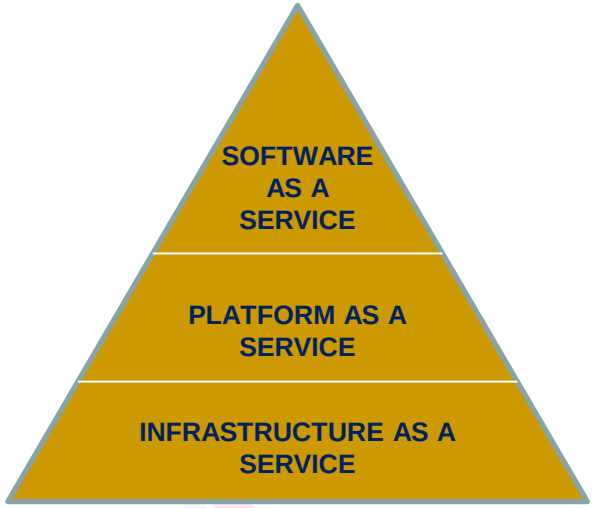
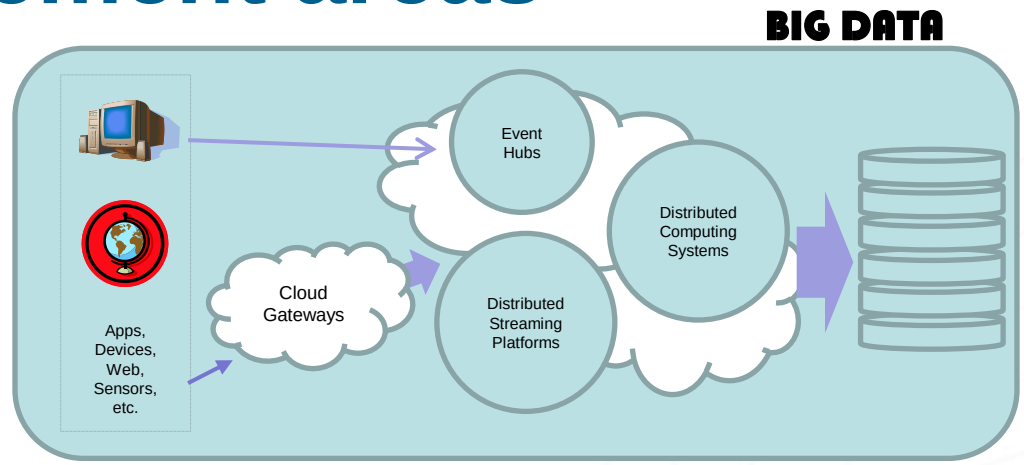
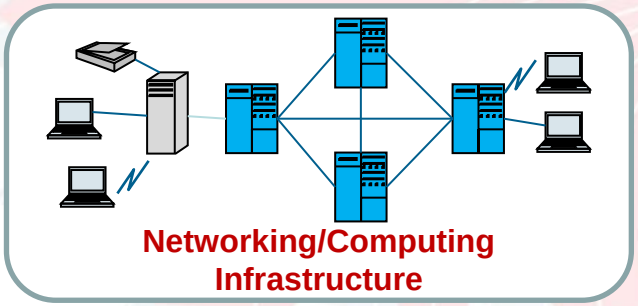
No O/S



Various advancement areas







Technology Stack

- Languages
- Content Management Services
- Content Delivery Network
- Caching
- Applications
- Databases
- Operating Systems

Technology vs product

Often the name of the product, process, or device is also used to identify the technology.

The distinction is,

1. Product, process, or device conveys feature, functionality, capability, etc.
2. Technology is about the knowledge of how the constituents embodied within the product, process or device, function to deliver the feature, functionality, capability, etc.

Example: Web information system publishing tools that also serve as document management and storage systems come with features, interfaces, APIs and tool-sets to build information systems. (cont'd)

Technology vs product (cont'd)

- Understanding the capabilities and limitations of such systems for building an information system, use of their API/interfaces to develop an information system, or information about their features and functionality **are about a product**.

- On the other hand, knowledge of the internal workings of such systems and how inter-relationships produce, influence, and impact the features, interfaces, APIs, tool-sets etc., are **related to the technology**.

Technological uncertainty and associated key concepts – Q1

- Scientific or technological uncertainty means whether a given result or objective can be achieved or how to achieve it, is not known or determined on the basis of generally available scientific or technological knowledge or experience.

- Scientific or technological knowledge base refers to the existing level of technology and scientific knowledge, and consists of the knowledge of the resources within the company and sources available publicly.

- The current state of technology may be insufficient to resolve a problem. Therefore it is important to identify the shortcomings or limitations of technology that prevent the new or improved feature, functionality, capability from being developed.

Example – Establishing the technological knowledge base

- As an example, we can think of a telecom software company developing Automatic Call Distributors (ACD) for VoIP based voice telephony, wants to prevent failures in SIP calls due to hardware, software, system, or network failures.

- Peer to peer connections through data network are susceptible to such failures resulting in session disruptions.

- For voice sessions over data, this has the undesirable effect of loss of on-going phone calls and call setup in progress.

(cont'd)

Example – Establishing the technological knowledge base (cont'd)

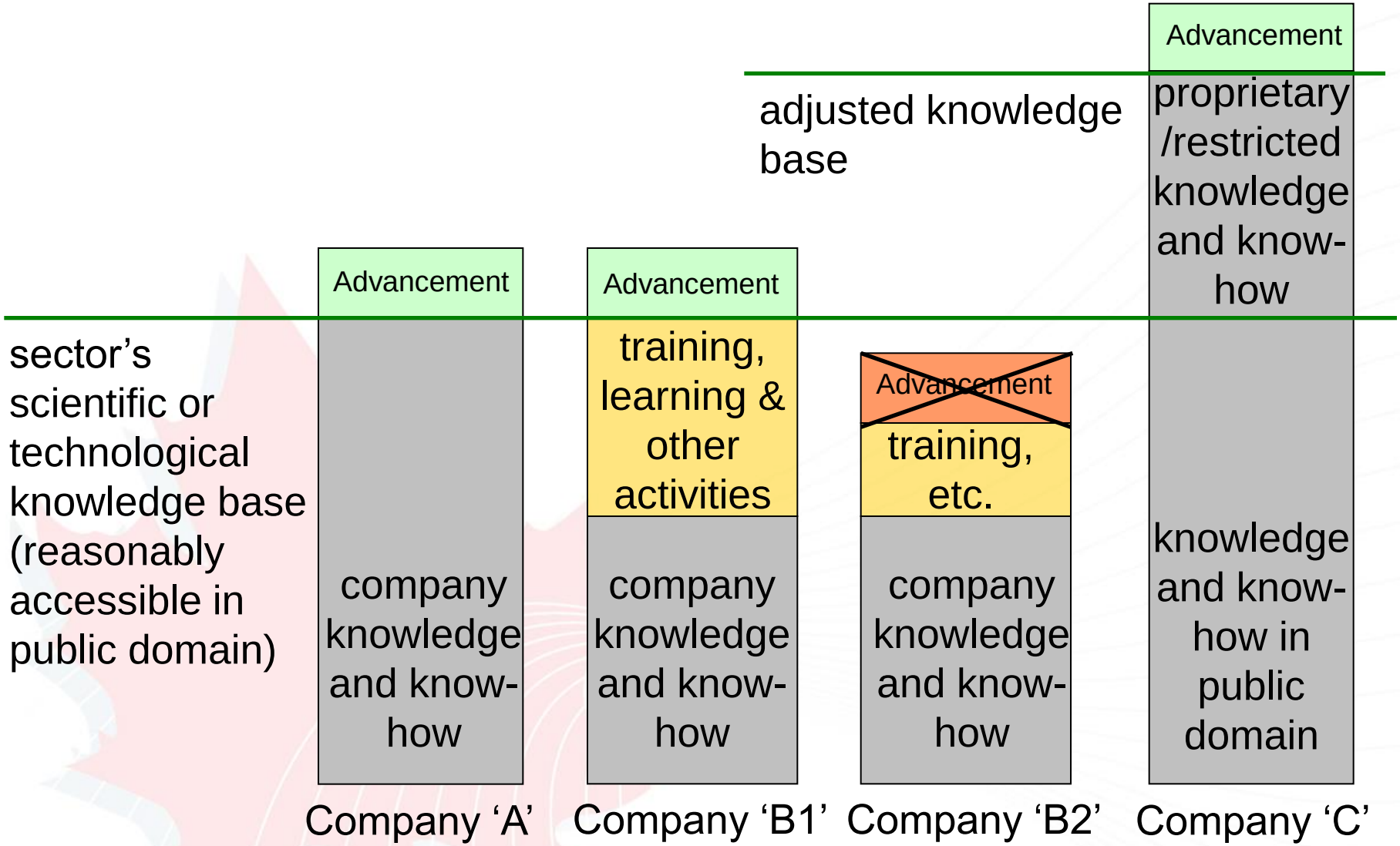
- This company asserts that the objective of call continuity (continuing phone calls without re-initiating them), cannot be achieved based on the technological knowledge base.
- The information used by the company in coming to such a conclusion can help in establishing the technological knowledge base.
  - starting with identifying the technology or technologies involved (such as SIP, SDP, RTP and their interactions);
  - identifying what is available in the technological knowledge base with regard to peer to peer calling, failure modes, call set-up, call progress, and call tear-down;
  - describing any proprietary technology involved;

(cont'd)

Example – Establishing the technological knowledge base (cont'd)

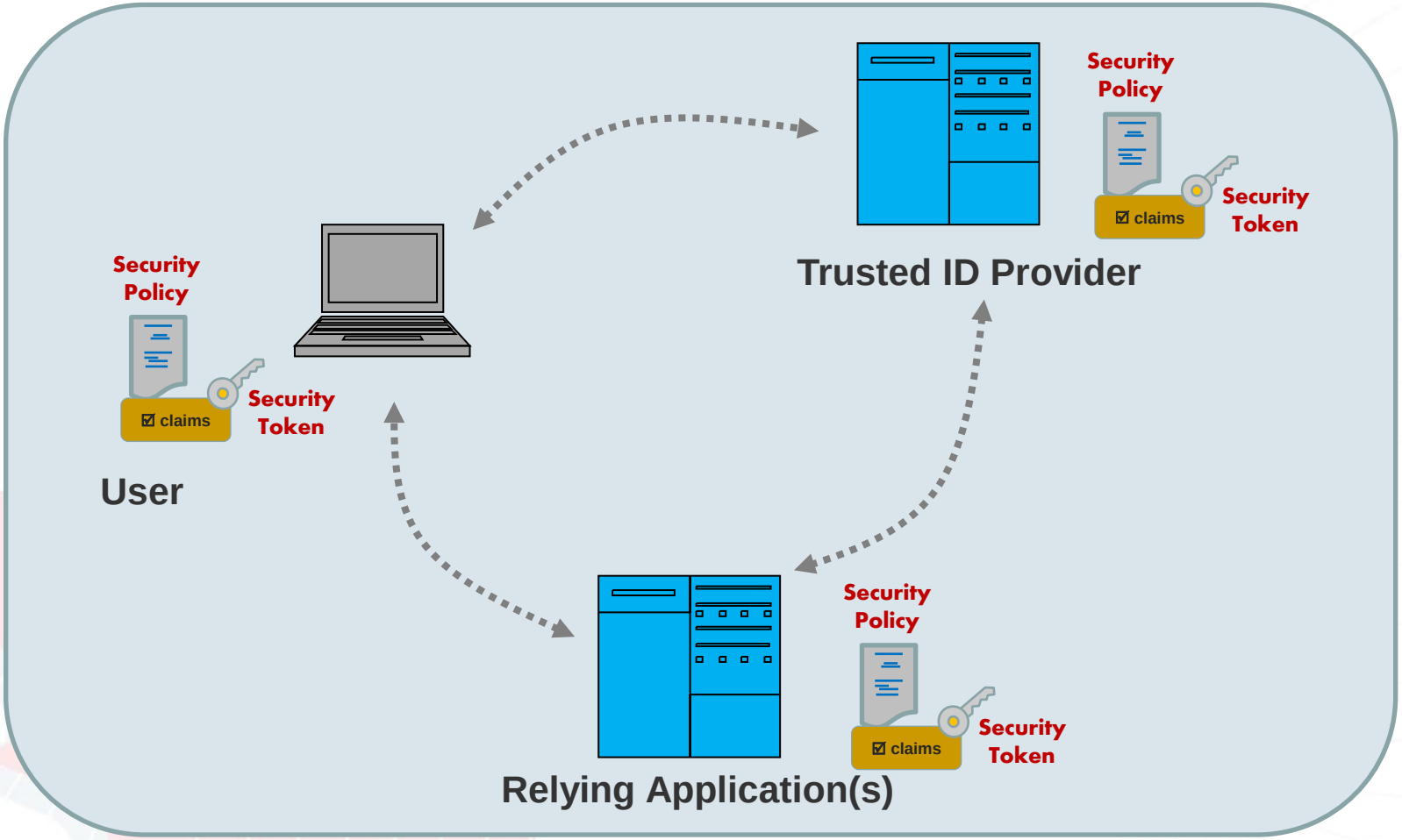
- identifying any patents or technical information associated with how call failures are handled using the current state of technology;
- providing the technological experience of the company in the technology areas such as VoIP, Information theory, Voice telephony, Network protocol knowledge of TCP/UDP/SIP/SDP/RTP, etc.;
- identifying where the current state of technology is insufficient; and
- having this research documented when it was done in order to establish the technological knowledge base at that specific point in time.

Scientific or technological knowledge base scenarios



Example: Identifying a limitation of technology

Background:



Example: Identifying a limitation of technology (cont'd)

- In 2013, a leading software company XYZ offered Cloud based access to its productivity software suite and related services through single email login authentication.

- Its single sign-on (SSO) login capability was constructed on claims based user identity using its Cloud based directory and identity management service.

(cont'd)

Example: Identifying a limitation of technology (cont'd)

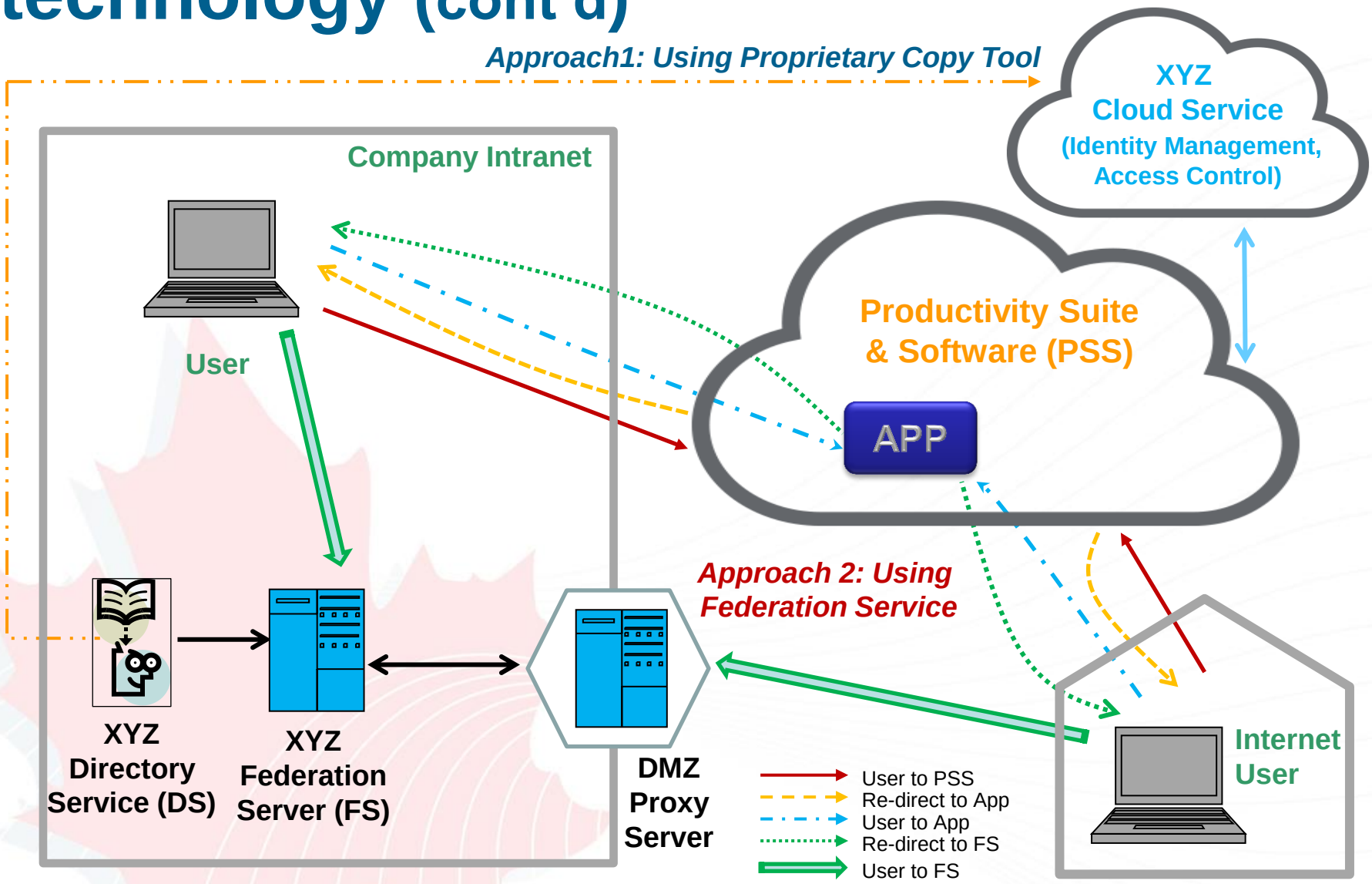
Available approaches for single sign-on with XYZ Cloud

1. Transferring information from an organization's internal directory service to the Cloud using a proprietary tool: This tool provided by the XYZ company synchronized essential information from the internal directory service of an organization into the user identity management of the Cloud. This provided local users of the organization, access to applications in the Cloud from outside.

2. Federation Services: The XYZ company offered a federated service software which would serve as a Security Token Service (STS), relying on individual domain controllers, to perform authentication and provide security tokens. In this implementation, the Cloud identity management trusted the security tokens from the federated service for single sign-on.

(cont'd)

Example: Identifying a limitation of technology (cont'd)



Example: Identifying a limitation of technology (cont'd)

Issues with these approaches:

Both these approaches impose restriction on usernames through namespace hierarchies based on domain segregation. Additionally,

- Approach 1 is not a true single sign-on, rather a way to allow internal users to access from outside.
- Approach 2 is a single sign-on but requires a federation server and proxy server for every domain controller. It also uses domain user accounts for login.

As an example, a company wants a single sign-on solution using XYZ Cloud's identity and access control that did not have username restrictions or require the Federation Service for identity management.

(cont'd)

Example: Identifying a limitation of technology (cont'd)

Limitation of Technology:

- The federated single sign-on option available in the XYZ Cloud was using WS-Federation protocol.
- The Cloud's identity management trusted the Federation Service to provide the security tokens.
- The technological knowledge base, including understanding of how the XYZ Cloud's identity management worked, was insufficient for the company to develop a solution to overcome the restrictions imposed by approach 2.
- At this stage, this is a limitation of the current state of technology.
- Work can be undertaken to advance the knowledge towards the development of this solution that will enable single sign-on.

Example – Absence of a capability does not equate to a technological uncertainty

A company wants to build a new version of their client server mobile application. The older version of the application worked in conjunction with a well known Enterprise Server that offered server side Push capability. The new version of the application was required to work in setups where the Enterprise Server could not be used.

- Typically, in client server applications, the server responds to client requests. This well known Enterprise Server offered a server side Push service, where client applications can receive information from their servers even if they did not initiate a request.
- The company cannot claim the lack of availability of the Push capability from the Enterprise server as a technological uncertainty for its work to develop some form of a Push service. The company has to identify a limitation of technology that is preventing the development of its own Push service.

Example – Differentiating project objective and technological uncertainty

- A state of the art Natural Language Processing (NLP) based software processes English language sentences at a rate of **N** words per second (**wps**) with an accuracy of 75% while interpreting the meaning/intent in social media conversations.

- The company seeks to improve the software to **1.3*N** wps at an accuracy rate of 85%. This conveys a project objective without conveying a limitation of technology that prevents the company from achieving this objective.

- Stating that there was uncertainty in whether or not the project objective can be achieved does not convey the limitation of current state of technology.

(cont'd)

Example – Differentiating project objective and technological uncertainty (cont'd)

- Performance targets, measure of efficiency, scaling requirements, measure of redundancy, and reliability are indicators of a product, process, device or material.

- One of the reasons why a certain value of a metric is unachievable may be due to existence of a technological uncertainty. However, wanting to achieve it is a functional objective, and an attempt to achieve it does not necessarily mean an attempt to achieve technological advancement by eliminating a technological uncertainty.

Example – Circumventing the limitation of technology

- During new or improved product development, an encountered issue can be suspected as being due to a limitation of the technology.
- A company can choose to develop a solution by circumventing or avoiding the issue by using alternatives.
- In such a scenario, the identified issue cannot be considered as the technological uncertainty.

(cont’d)

Example – Circumventing the limitation of technology (cont'd)

- A company has a large development group for developing third party applications for a mobile operating system. While developing mobile apps using a particular Software Development Kit (SDK), the company found that apps would fail randomly while handling large data at a fast rate.

- Preliminary investigation and analysis led to the suspicion that the failure might be due to either:
  - Issues in virtual memory management in the SDK library or
  - A poorly built library that is unreliable.

(cont'd)

Example – Circumventing the limitation of technology (cont'd)

- After due consideration, the company chose not to address the SDK issue and instead decided to build their own SDK.
- Since the issues of the existing SDK are not directly related to the development of the new SDK, they cannot be cited as a limitation of technology for the development of the new SDK.
- It is important to identify if a limitation of technology is preventing the development of the new SDK.

Important points about technological uncertainty

- Technological uncertainty conveys the idea that there is a problem or barrier that is technological in nature and that cannot be resolved using the knowledge and information available in the technological knowledge base.
- It identifies the point where the nature of work shifts from using the technological knowledge base, to finding a solution by addressing the limitation of technology.
- Confirmation that work was undertaken to reduce or eliminate a technological uncertainty is obtained through the details of the work. This will also rule out the cases where:
  - The work undertaken circumvented the limitation or
  - The outcome of the work undertaken is within the technological knowledge base
- Once a technological uncertainty is identified, the techniques used for systematic investigation or search can be techniques that are within the technological knowledge base.

Formulating hypotheses specifically aimed at reducing or eliminating the technological uncertainty – Q2

- Hypothesis is an idea consistent with known facts.
  - **Example**: Internet data transmission speed can exceed the speed of light is not consistent with known facts.
- Hypothesis is a supposition or explanation on the basis of limited evidence which serves as the starting point for further investigation.
  - **Example 1**: While going through technology stack selection to decide between two real-time O/S options, a supposition that real-time O/S ‘A’ will offer better interrupt management than real-time O/S ‘B’, has no linkage to anything lacking in the scientific or technological knowledge base. Therefore this is not a hypothesis for SR&ED.
  - **Example 2**: Continuing on the previous example on limitation of technology, a hypothesis can be that specific information from the Directory Service objects are used in the composition of claims for Cloud Service security tokens within WS-Federation. This is a hypothesis for SR&ED.

Systematic investigation or search (SIS) – Q3

- With the formulation of the initial hypothesis, the investigation or search continues through experiment or analysis to address the limitation of the current state of technology.

- The details of the work establishes if a systematic investigation or search (SIS) was carried out for the purpose of eliminating or reducing the technological uncertainty.

(cont'd)

Systematic investigation or search (SIS) (cont'd)

Scenario 1:

- The work undertaken confirms knowledge that is already in the technological knowledge base; and
- determines the suitability of alternate solutions from within the technological knowledge base.

Scenario 2:

- While building an innovative application, encountered issues were initially suspected as a limitation of technology but the work undertaken establishes that the solution is from the technological knowledge base.

Scenario 3:

- The work was undertaken to advance the understanding of the current state of technology beyond the technological knowledge base, reducing or eliminating a technological uncertainty.

(cont'd)

SIS - Scenario 1 example

Background:

- A company is building an online application that will allow users to query a very large database of information on products and pricing.
- The application utilizes user location to display products sorted based on proximity.
- The system requirements were set by search completion time and the ability to perform live updates to the database in a timely manner.

Work undertaken:

- An initial system was built with a modern Relational Database Management System (RDBMS).
- The search performance did not meet the requirement of search time and the live updates were taking too long.
- The time consumed by the individual processes of the work-flow was measured starting from user-input to displaying final result.
- This identified computations that were taking too long. (cont'd)

SIS – scenario 1 example (cont'd)

- Identical repetitive computations were replaced with look-up tables and cached database tables to reduce search time.
- The cache memory was not sufficient as there were too many large tables.
- The large tables were necessary to avoid complex queries with dependence on multiple tables.
- Changes were made and it did not provide consistent performance improvement. The overall search time performance did not improve to the desired level.

An alternate solution was built using a search platform with advanced text search capabilities. The search performance time turned out to be well within requirements but the database updates did not meet the requirements.

- This was investigated and changes were made to the configuration of the search platform that improved update metrics.

(cont'd)

SIS – scenario 1 example (cont'd)

Conclusion:

The first part of the work identified knowledge already available in the technological knowledge base. The second part of the work in finding an alternate solution and optimizing it is also from within the technological knowledge base.

SIS – scenario 2 example

Project objective and development work:

- An app developer for a popular mobile phone operating system was asked to develop a unique secure file transfer application that uses Wi-Fi to send and receive many pre-scheduled files to and from a central server.
- The user of the app is not constrained to stay connected to a Wi-Fi for the completion of the file transfers.
- An application was created with a capability to queue and schedule file transfers based on a standard secure file transfer protocol.
- Whenever the phone had Wi-Fi connectivity, the scheduler within the app would initiate and continue pre-scheduled data transfers.
- The application encountered transfer failures whenever the user moved out of a Wi-Fi range, requiring re-transfer or use of expensive wireless data. (cont'd)

SIS – scenario 2 example (cont'd)

Work undertaken:

- The testing of the issue revealed that the failures were more common when the file size was over a certain limit.
- The files were divided into smaller chunks, transmitted one chunk at a time, keeping track of the chunks transmitted.
- This solved the initial issue but created other issues like the device consuming too much resource and time in preparing the files thereby impacting scheduling.
- To overcome this, the developers decided to transmit fixed size data and keep track of the pointer to the end location of the last transmission to eliminate preparation time.

(cont'd)

SIS – scenario 2 example (cont'd)

Conclusion:

- Transmitting small size data, keeping track of files through pointers, and having a process to schedule/manage files and data within a file, are all from within the technological knowledge base.

- The work, though conducted systematically, was not towards reducing or eliminating a technological uncertainty. Therefore it is not considered a SIS for the purpose of resolving a technological uncertainty.

SIS – scenario 3 example

Work undertaken:

- A setup consisting of XYZ Cloud's Access Control Service using the Cloud's Directory Service instance as the ID provider for a relying application was created. A packet sniffing tool was setup to capture and analyze the user browser network traffic and log during login attempts. The Cloud's Directory Service was populated with user objects from a local Directory Service using the proprietary tool.

- The visibility of claims within the WS-Federation was confirmed during login attempts. The next effort was to understand the relationships between claim attributes and Directory Service user objects. The observations and analysis of the claim attributes of the captured information within security tokens, allowed the mapping and expression of the correlation between the Directory Service user object attributes and the object attributes used within the Cloud's identity management entities.

(cont'd)

SIS – scenario 3 example (cont'd)

- The next activities were towards validating the relationships, determining whether Security Token Service provided by the Federation Service can be substituted, and finding out what may be necessary to mimic any Federation Service specific behavior.
- To accomplish this, an open source security token server was setup. A trust association between the server and XYZ Cloud identity management was established. The signing algorithm and signing certificates were aligned between the two. These steps were necessary to configure the use of the security token server as the identity provider for the Cloud Service. Based on the developed relationships, the server source code was modified to create new claim types structured using Directory Service user object attributes.
- By undertaking several tests, it was possible to understand where and how the Directory Service object attributes were used in the claims for the Cloud Service. The results enabled the construction of a single sign-on approach for XYZ Cloud Service without Federation service where it was possible to use attributes and unique-ids that did not belong to the Directory Service. This also led to the development of user stores without the Directory Service. (cont'd)

SIS – scenario 3 example (cont'd)

Conclusion:

Information on the work undertaken is at sufficient level of detail that both a claimant and a reviewer from CRA can agree on the statements of facts, see the characteristics of the work undertaken, and identify new knowledge. With reasonable effort, the reviewer (and the claimant) can determine and agree if this is over and above the technological knowledge base.

Systematic investigation or search (SIS)

Additional points:

- If the work generates or confirms what is within the technological knowledge base, even though the work was undertaken systematically, it will not be considered as SIS for reducing or eliminating technological uncertainty.

- Work resulting in generation of new knowledge that explains the reasons of failure of possible solutions to achieve a technological objective is considered a technological advancement provided it is not available in the existing technological knowledge base.

Technological advancement – Q4

- Scientific or technological advancement is the generation of information or discovery of knowledge that advances the understanding of scientific relations or technology.
- Key milestones in the pursuit of technological advancement are:
  - identifying that there is a limitation in the current state of technology
  - undertaking work to address the limitation
  - work leading to an understanding of the principles, techniques, and concepts beyond the existing technological knowledge base
- Technological advancement is the new knowledge that is applicable beyond the current project.

Technological advancements in software development projects

- New/improved techniques and methods in computing to store, search, process, and manage vast collection of data (big data). Typically undertaken in Universities and large research labs.
- Advancements necessary in support of software technology stack or tools.
- Advancements necessary for new or improved infrastructures like internet driven Cloud and distributed computing.
- Advancements necessary to support scaling, reliability, and availability of software based systems.
- Advancements in other technology areas like vision and medical imaging, video transmission, telecommunication (voice), Automation, Controls, etc.

Technological advancement

- Built an online application that displays search information of available products and pricing based on proximity to the user as well as performing tasks within time requirements.
  - **Question**: Is this a technological advancement?
  - **Answer**: No
  - **Why?** Because it describes functionality and capability of an application and does not convey the technological advancement required to build the capability or functionality.

Technological advancement

- Created an application that delivers a secure file transfer capability with features and functionality that are unique.
  - **Question**: Is this a technological advancement?
  - **Answer**: No
  - **Why?** Novelty and feature/functionality of the app was achieved using information/techniques available in the technological knowledge base. It did not require a technological advancement.

Technological advancement

- Understanding where and how the Directory Service user object attributes are used in the claims, how they are mapped to the security tokens, their relationships to the Cloud identity management user object attributes and ruling out the need to have Federation Service.
  - **Question**: Is this a technological advancement?
  - **Answer**: Yes
  - **Why?** This knowledge is the technological advancement that allowed the building of the capabilities like SSO without Federation Service and creating user store independent of Directory Service.

Note: In this case, achievement of SSO capability on its own is not the technological advancement.

Was a record of the hypotheses tested and the results kept as the work progressed? – Q5

Why is this important?

- The records confirm that the work described during a review was performed.
- It is a record of hypotheses, tests, and results that shows the progress of work.
- It reveals the analysis of results from each step and how it is applied to the next step.
- It also shows if indicators and measures identified to determine if the goals of the work are being met, are recorded.
- Tracking and retaining these records bring out the results of the work.

Example - record of the hypotheses tested and the results kept as the work progressed

The work described in the previous example on the development of a single sign-on method, is made of hypotheses, tests, and results as it progressed.

This is used as an example to provide instances of naturally produced results of testing and organized recording as work progressed:

- Confirmation of the visibility of Directory Service user attributes inside the claims within WS-Federation credentials was done using a packet sniffing and analysis tool and therefore the following results would have been naturally or easily produced:
  - Screen-capture or log of the responses identifying the tokens with claims.
  - The recognizable attributes of the Directory Service user objects with or without encoding.

(cont'd)

Example - record of the hypotheses tested and the results kept as the work progressed (cont'd)

- The next step to map the attributes to the claim identifiers should produce:
  - Names and format of expression of all the claim identifiers and their associated user objects in the claims

- The trust association between the generic Security Token Server and the XYZ Cloud was set-up and made functional. A screen capture of the response of the commands used to establish this will provide the details of what this step accomplished.

(cont'd)

Example - record of the hypotheses tested and the results kept as the work progressed (cont'd)

- Finally, code changes were introduced and modified in the generic Security Token Server to enable claim construction. Several tests were conducted and adjustments were made based on the results of the tests to enable successful claims within WS-Federation. This work should have:
  - Initial modification to the source code to create claims and the results of using it
  - Changes made based on the results of previous tests and their outcome
  - Final code

Points to Remember

- Software development has become intrinsic to new or improved products/services in many sectors.

- There is prolific and unprecedented development of complex applications using software. This is driving the need for technological advancement.

- Technological advancement may be either in software technology or other fields.

- Within software technology, advancements happen at various levels.

Points to Remember (cont'd)

- Technology is knowledge and not a physical thing.
- The five-question methodology applies to software development as in any other field.
- Identifying the technological knowledge base properly is important.
- Limitation of technology needs to be articulated by correlating it with the technological knowledge base.

Points to Remember (cont'd)

- Not all systematic work is a systematic investigation or search as required in SR&ED.

- By showing why a possible solution will not succeed or will not meet the desired objectives, advancement is still possible.

- Record of hypotheses tested and results generated is important for demonstrating that a systematic investigation or search took place.

Conclusion

In this webinar, through examples, we have illustrated some of the key concepts associated with the Step 1 of the *Eligibility of Work for SR&ED Investment Tax Credits Policy* for claims containing software development.

Questions?