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Technical Developments Behind the Advanced Transparency Framework

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Outline

- Advanced Transparency Framework
- Project Scope
- Technological Developments
- Future Work and Conclusions

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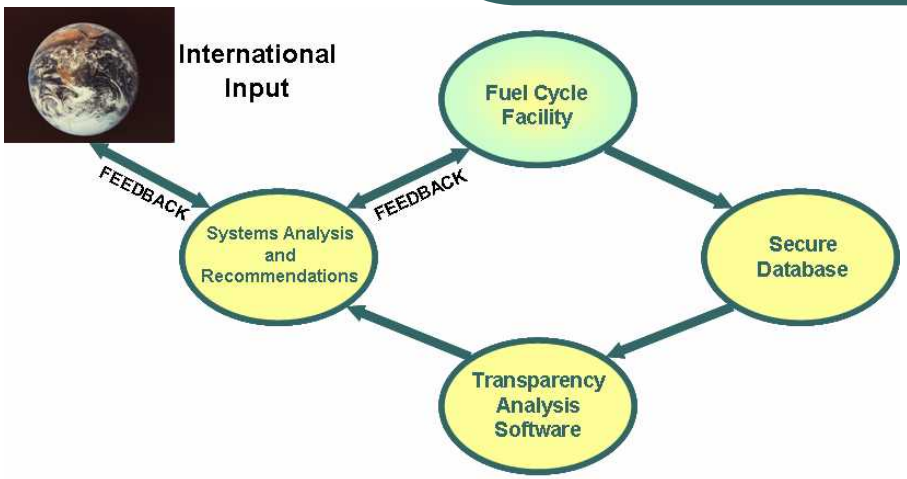
NUCLEAR ENERGY & GLOBAL SECURITY TECHNOLOGIES

Transparency **is a confidence building approach among political entities to ensure civilian nuclear facilities are not being used for the development of nuclear weapons**

Nuclear fuel cycle transparency involves the cooperative sharing of relevant nuclear material, process and facility information among all authorized parties to ensure the *safe and legitimate* use of nuclear material and technology

A system is transparent when all parties feel that the proliferation risk is at an acceptable level. For this to occur, proliferation risk should be monitored in a continuous fashion.



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NEW

Increasingly automated fuel handling activities
Use of process data
Real-time quantitative analysis

OLD

Monitoring fuel handling activities by inspection
Slow and subjective

REDEFINING TRANSPARENCY

A traditional transparency system involves:

- Use of external devices
- Comparison of recorded and declared activities
- Provides no feedback

An advanced transparency system MUST:

- Operate in real-time
- Utilize plant process and design data
- Utilize declared plant processes
- Conduct real-time, quantitative analysis of proliferation-risk
- Securely provide analysis to the facility and authorized parties

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Project Scope

- Utilizing the framework developed by Sandia National Laboratories & Japan Atomic Energy Agency (JAEA)
  - Demonstrate advanced transparency at the Monju Nuclear Fuel Cycle Model at the International Nuclear Information Training Center/JAEA
- New innovations:
  - Continuous, real-time monitoring of process and signal data internal to nuclear fuel cycle facilities
  - Calculation of diversion risk in real-time utilizing inherent process data

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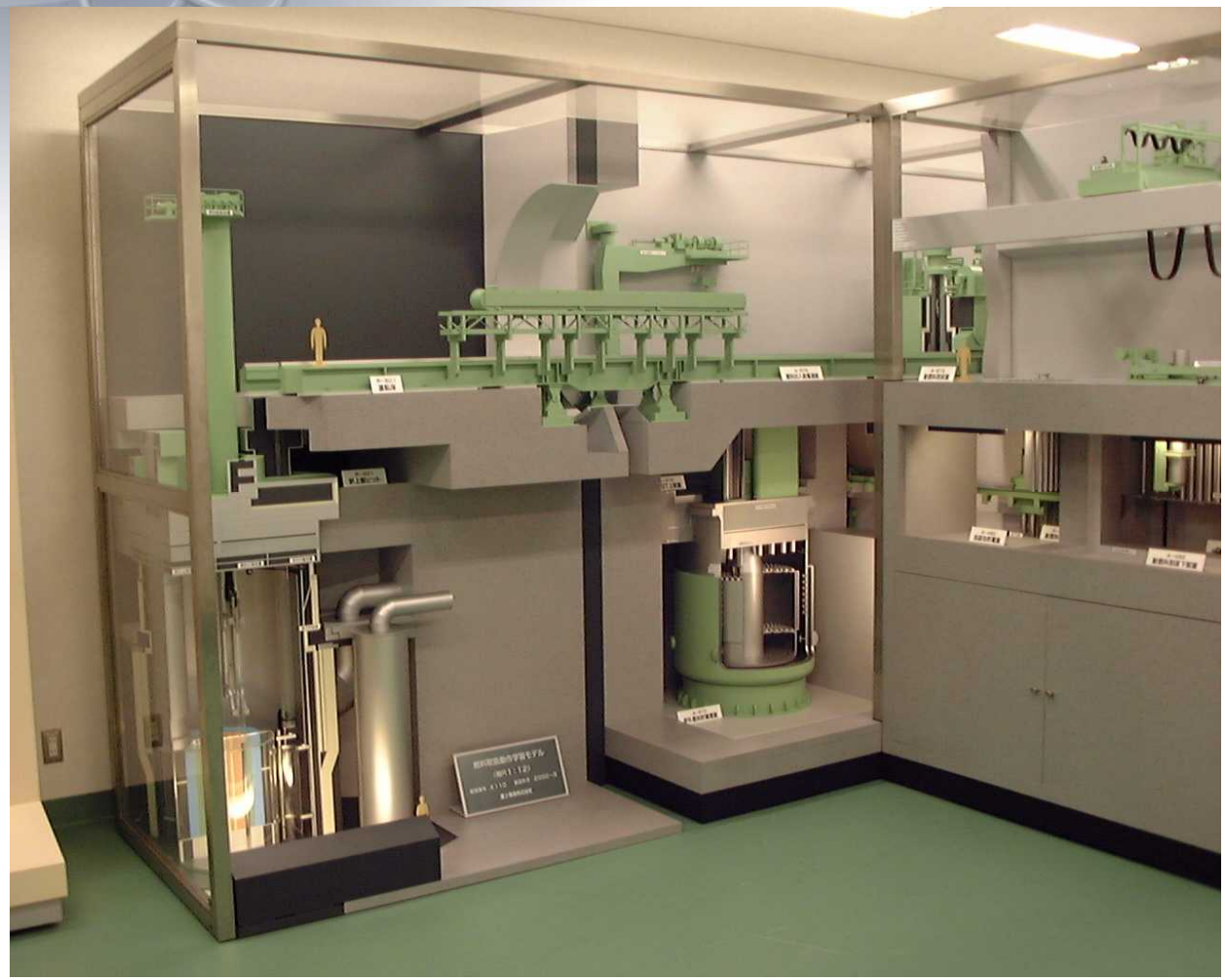
Monju Nuclear Fuel Cycle Training Model



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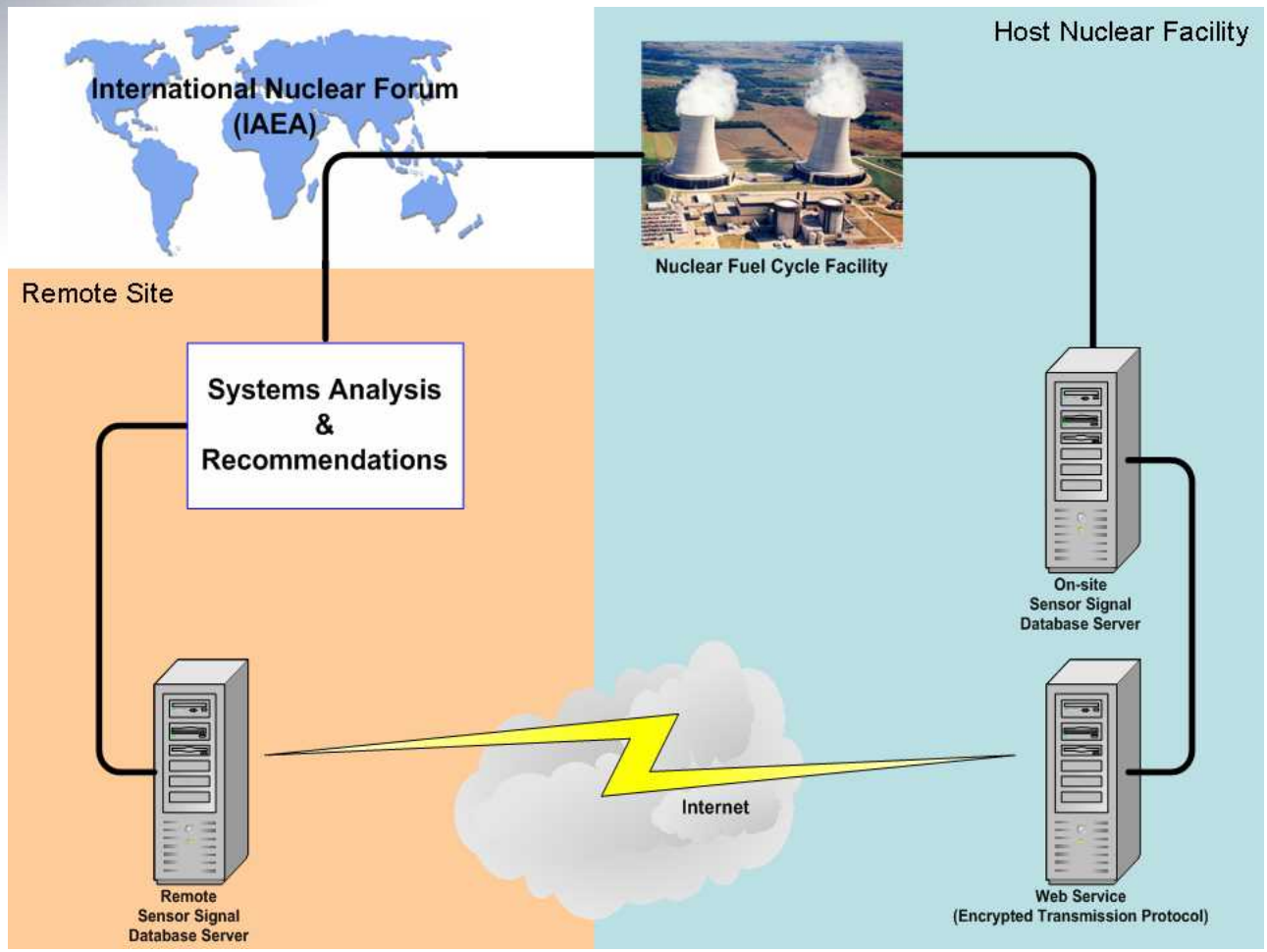
Conceptual Framework for Advanced Transparency



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XML Client Module

- The raw, binary, inherent, process data from the automated system is encrypted at the facility and securely transferred to the remote site, where the information is decrypted.
- This information is transferred through a Virtual Private Network.
- Functionality:
  - Scan a folder and subfolders in the host/Japan computer to detect when a change has been made
  - Select and transfer a copy of an XML file from the host/Japan computer to the remote/Sandia computer for storage & analysis.

XML Reader Module

- After information is transferred from the Server to the Client, an XML Reader parses through the information and populates the Transparency Database
- Functionality:
  - Read the XML doc containing sensor signal information gathered from the source site and transmitted via VPN/Client Module
  - Transfer XML contents into an Access or SQL Server database where they are stored for analysis

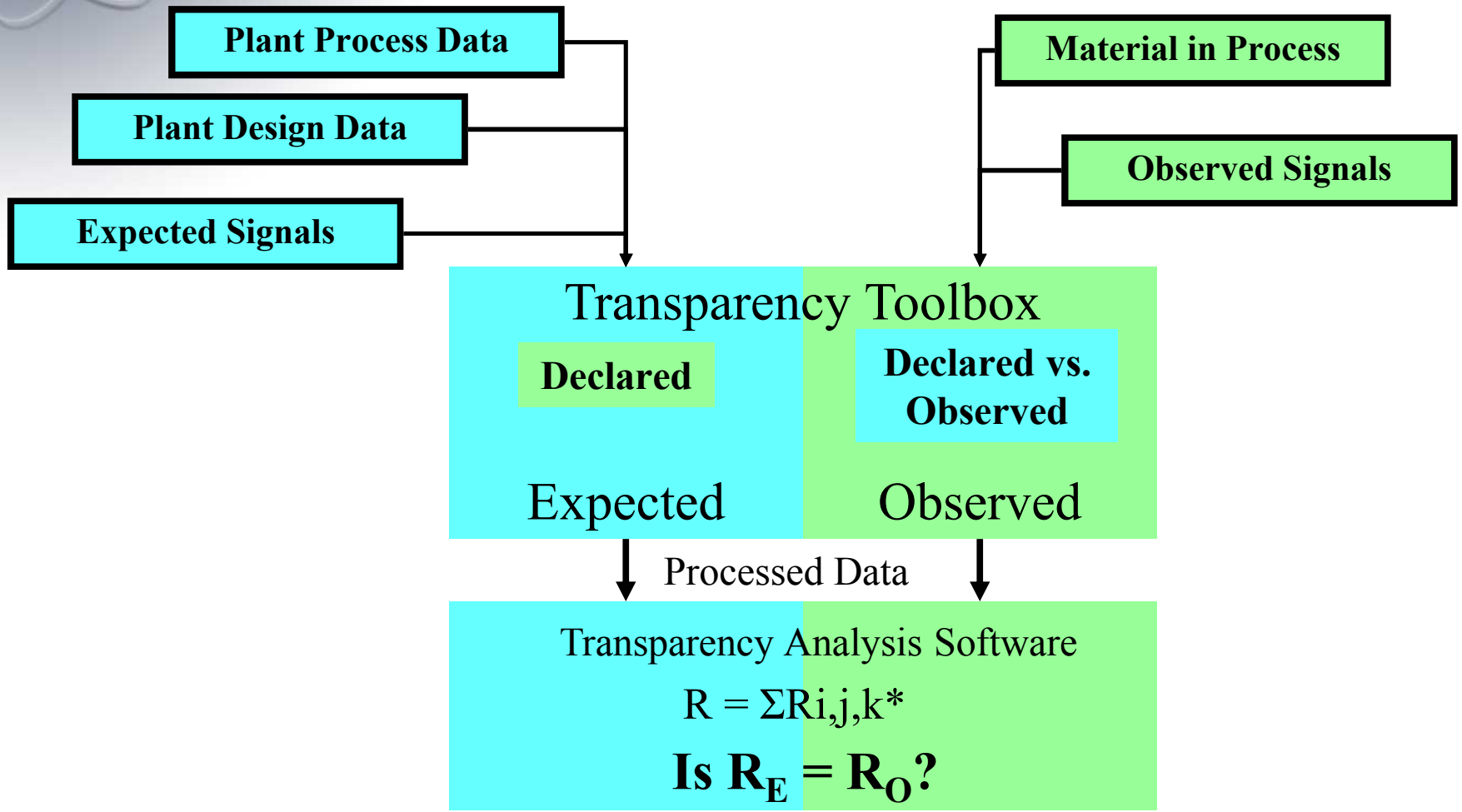
Transparency Toolbox Module

- The Transparency Toolbox is the main Graphical User Interface (GUI) at the remote site.
- The Toolbox is used to display information and facilitate development of constraints.
- Functionality:
  - View: Schematics, Signal Records and Status, Datasheet, Calendar, Diagrams, Material Inventories, Constraints
  - Data Managers: Sensors, Risk Analysis, Reports
  - Toolbox can interact with Analysis Software in real time, as data is being processed, to display real time reports and analysis results

Analysis Software Module

- The Transparency Analysis Software conducts the operational verification and calculates the diversion risk of a nuclear facility.
- The software incorporates quantitative analysis tools that evaluate the process data to determine the diversion risk.
- Functionality:
  - Sensor data: order of operations, signal interpretation
  - Risk analysis, logic tests

Diversion Risk Analysis



*where i,j,k = step, process, plant

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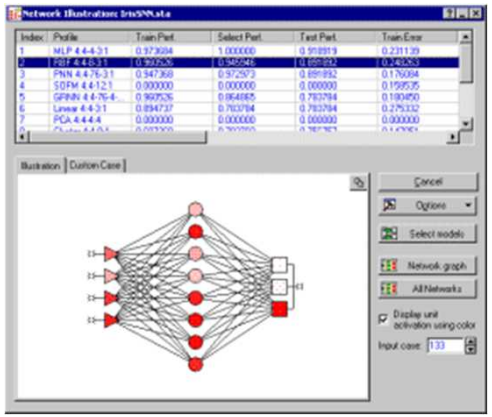
Data Security, Verification and Validation

- Transparency systems can be constructed that restrict access of sensitive information to only authorized regulatory parties.
- Through verification and validation techniques data transmitted from the nuclear facility via the advanced transparency framework can be guaranteed as secure and reliable.

Encrypted Tamper Resistant Virtual Network



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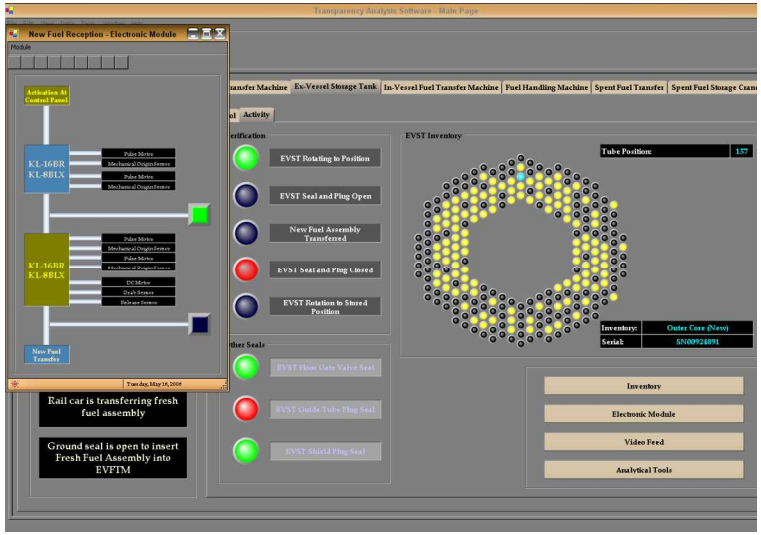
Technical Developments



- Accurate collection of signals internal to the Monju Nuclear Fuel Cycle Model
- Live collection and transfer of these signals from the Monju Database Server (in Japan) to Sandia
- Accurate interpretation of signals in accordance with model operations
- Detection of “manual override events” or interruptions in automated processes

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Conclusions

- Augmentation of the current transparency ideology can support the IAEA mission to ensure safe and peaceful use of nuclear technology.
- A real-time analysis is important due to the speed at which proliferation can occur.
- New ideas for fuel cycle transparency can result in increased confidence and optimized resources.
- A new paradigm can be utilized to facilitate deployment of nuclear technology to developing nations, optimize inspections, and enforce agreements.