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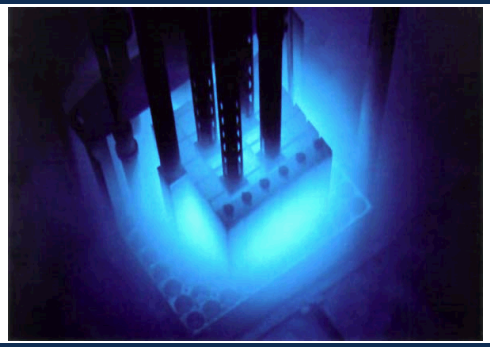

Prototype Hardware and Software for the Secure Branching of Facility Instrumentation

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National Nuclear Security Administration

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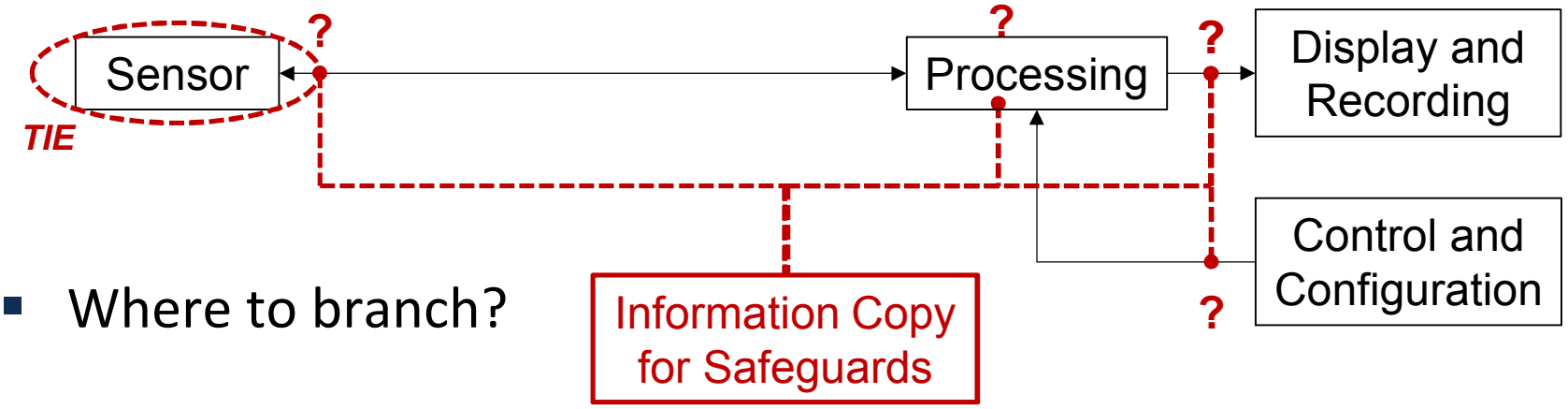
Branching approach: “listen” to the operator instrumentation, close to the sensor

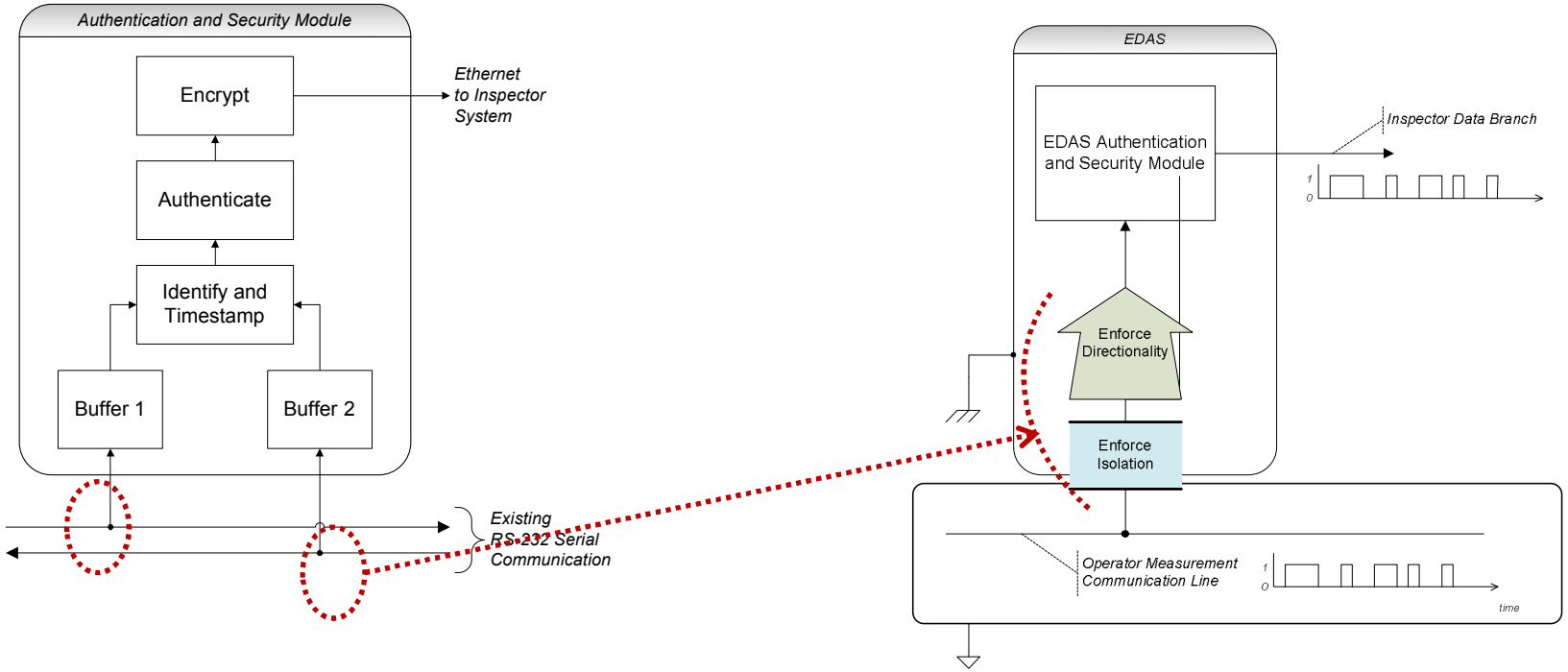
- Operator instrumentation system:



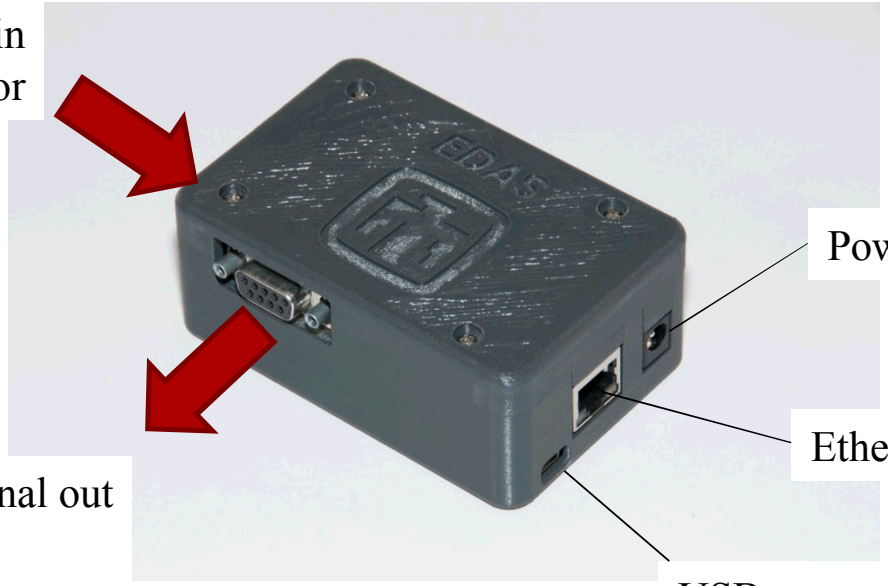
- Where to branch?
- EDAS: “Enhanced Data Authentication System”
- The EDAS design philosophy is
  - 1) faithful replication of operator data
  - 2) meet trust and security requirements of both inspector and operator
- Requirements can be met by blindly copying data bits as close as possible to the data source

The EDAS redesign extends previous work

- Branching originally used simple signal line “splitters”
- The latest design assures non-interference



Connections to the EDAS Junction Box



EDAS is non-interfering: A custom circuit board isolates the operator signals from EDAS

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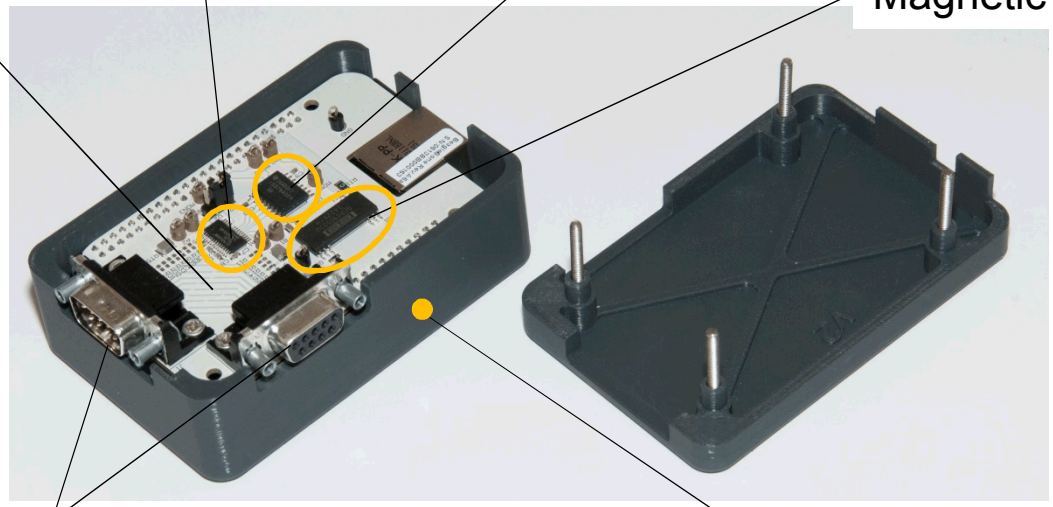
Transceiver interprets the RS-232 signals as 0's or 1's

Capacitive data isolator

Signal lines are continuous between the connectors

Magnetic power isolator



9-pin RS-232 connectors for operator signal in / out
(able to be bypassed manually if operator chooses)

BeagleBone Black processor (underneath the custom board)

How EDAS “listens” to the operator instrumentation:

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- Transceiver detects the RS232 data levels (0’s and 1’s)
  - Receive (Rx)
  - Transmit (Tx)
- The data levels pass across a one-way isolation barrier
- EDAS buffers accumulate a copy of the RS232 data
- EDAS decides how to group the data into packets
- Each data packet is
  - Identified and time-stamped
  - Authenticated
  - Encrypted
  - Pushed out over TCP/IP to an inspector computer

EDAS logic to assemble data packets can be configured as required

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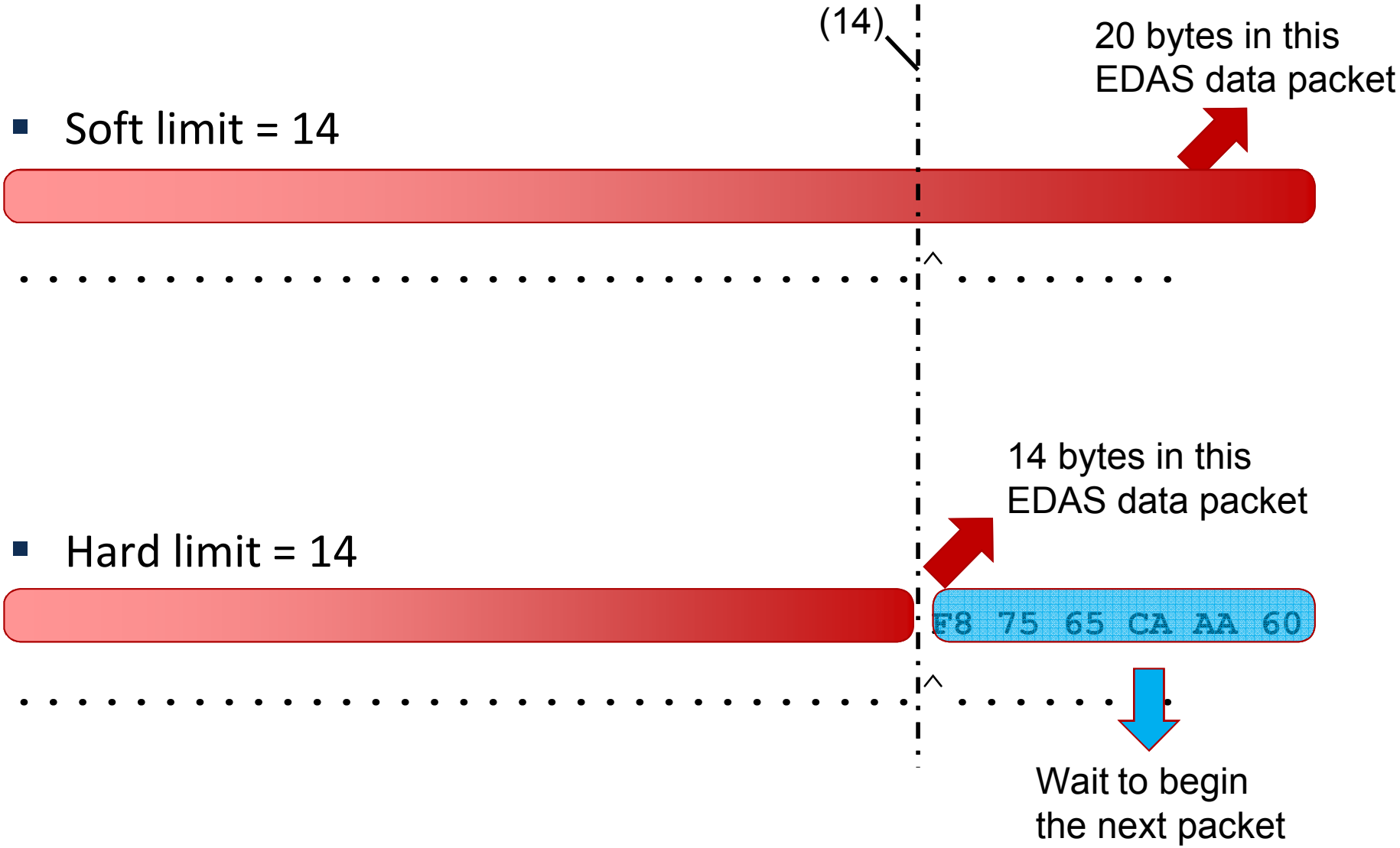
- Time
  - As soon as data start to accumulate in the buffer, a clock starts
  - As soon as the elapsed clock time reaches a preset time limit, EDAS will packetize the buffered data
- Amount of data (“size”)
  - Soft limit
    - As soon as the number of bytes exceeds a specified size, EDAS will packetize all of the buffered data
  - Hard limit
    - As soon as the buffer exceeds a specified size, EDAS packetizes only that fixed number of bytes
    - bytes beyond the hard limit
      - Are retained in the buffer
      - Start the next data block

Examples of size limits for data packets



EDAS processes its copy of the operator data

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- Time stamp and identity
  - Transmit (Tx) or Receive (Rx) line
  - Internal clock, set by inspector computer
- Authentication
  - EDAS cryptographically signs the data blocks sent to the inspector computer
  - Ensures both the integrity and the source of the data
- Encryption
  - EDAS ensures the confidentiality of the operator data copy
  - Secret key encryption established by Diffie-Helman key exchange
- Data are “pushed” to the inspector computer using TCP/IP

EDAS operations are implemented with custom software on a commercial platform

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- BeagleBone Black commercial processor
- Linux operating system
- Software written in Java
- Bouncy Castle cryptographic library for authentication and encryption (open source)
- Inspector computer software runs on Windows 7
- Automatic operation
  - Linux operating system starts as soon as power is available over USB
  - Operating system loads and runs the EDAS software immediately
  - EDAS software is designed to begin asynchronously
  - EDAS sends “heartbeat” state-of-health messages as well as data packets
  - Robust: can recover from power lapses, breaks in signal connections, etc.

Discussion

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- Isolation of EDAS from the operator signal line
  - Operator signal does not depend on, nor is affected by EDAS
- Fail-safe operation
  - EDAS starts up and recovers automatically; operation is asynchronous
- Accurate, complete and meaningful branched data
  - Prescriptive logic can optimize formation of data packets, but data stream can be reassembled faithfully however the time/size limits are set
  - What those bytes actually *mean* must be determined separately
- Data confidentiality and authentication
  - Encryption prevents an eavesdropper from obtaining the branched data
  - Encryption does *not* prevent an eavesdropper from detecting operation
  - Authentication assures both the source and integrity of the branched data

Status and Next Steps

- EDAS is currently undergoing extensive testing
  - Sandia: functional and system testing
  - Partners (European Commission) conducting other tests to assess performance
- EDAS integration with inspectorate data collection system
  - DG-ENER is developing software that will interface EDAS with RADAR, used in Euratom safeguards
- Planning is underway for a forthcoming field trial

- Future considerations:
  - Fitting EDAS with a tamper-indicating enclosure
  - Adapting to other instrumentation interfaces
  - Transition from custom to production availability

Conclusion

- EDAS ensures that the branched information is a secure, true, and complete replica of an operator data stream.
- By design, EDAS is intended to minimize risk to an operator system from branching.
- We are now in a testing phase and will soon be ready to consider deployment aspects

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