Virtual Satellite Integration and The SpaceWire Internet Tunnel

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Introduction

- Satellite Integration
  - Limitations of existing methods
  - Virtual Satellite Integration
- SpaceWire Internet Tunnel
  - Hardware
  - Software
- Current and Future Developments
  - Pilot Activity
  - Tunnel Server
  - Tunnel Improvements
- Summary

Existing Methods of Integration

- Problem of geographical separation
- Importance of interface specifications
- Advantages of standard interfaces
  - SpaceWire
- Problems still possible at higher layers
  - e.g. Application level
- Integration Testing performed late in development process

Virtual Satellite Integration

- Remote sub-systems connected using the Internet
- Reduces geographical limitations and travel
- Problems can be identified in interface specifications and implementations
- Integration can be performed earlier in the development process
- Also allows sub-systems to be transparently replaced with simulators

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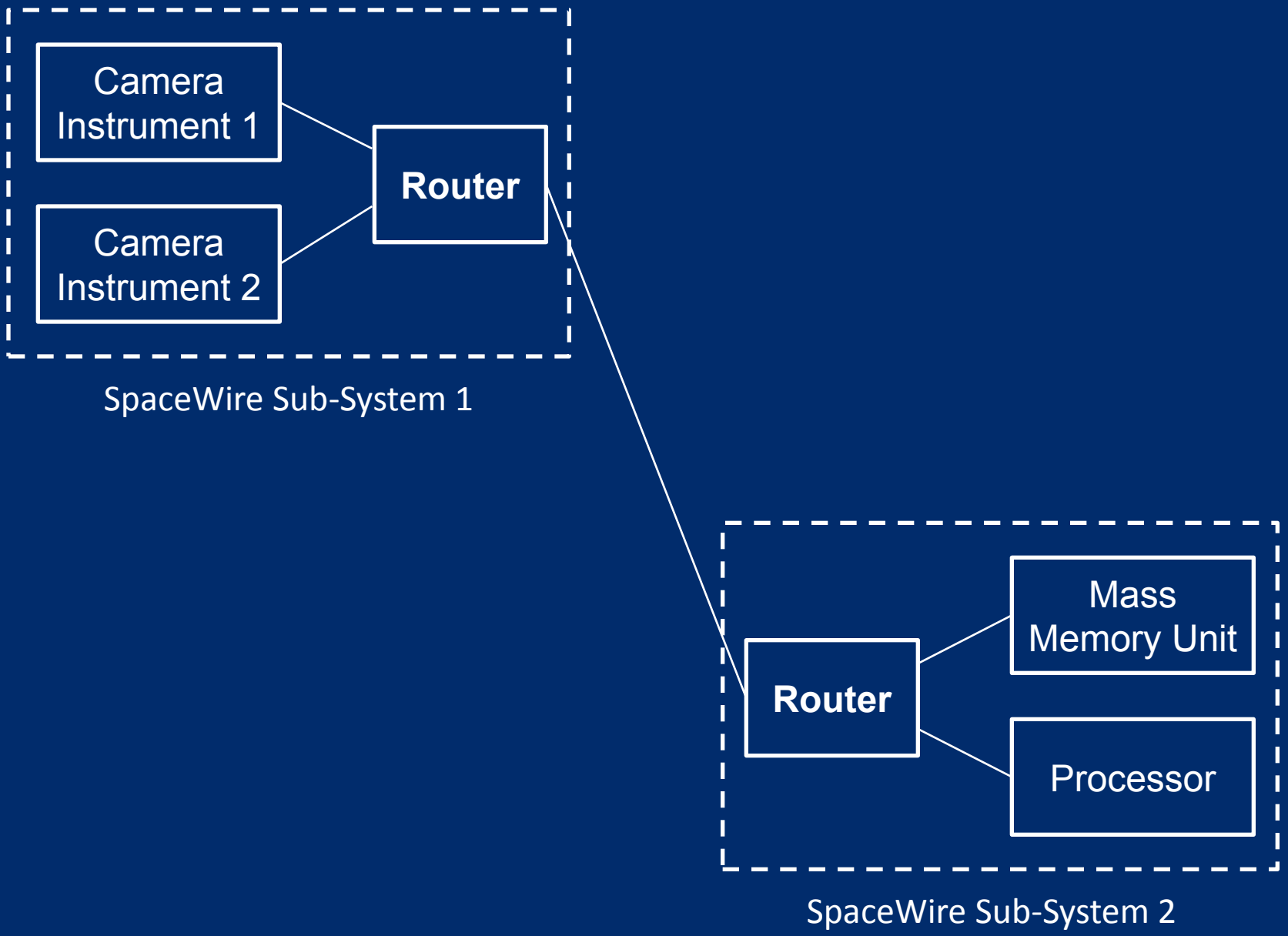
The SpaceWire Internet Tunnel

- Transparently replaces a SpaceWire link
- Traffic entering the Tunnel will exit in the same order
  - e.g. a time-code will be between the same two data characters
- Link start and disconnect is also represented
- Only difference is in bandwidth and latency
  - Limitations of Internet
- Hardware and software solution
  - Protocol Analysis software also provided to monitor the Tunnelled traffic

Example Network With Two Sub-Systems



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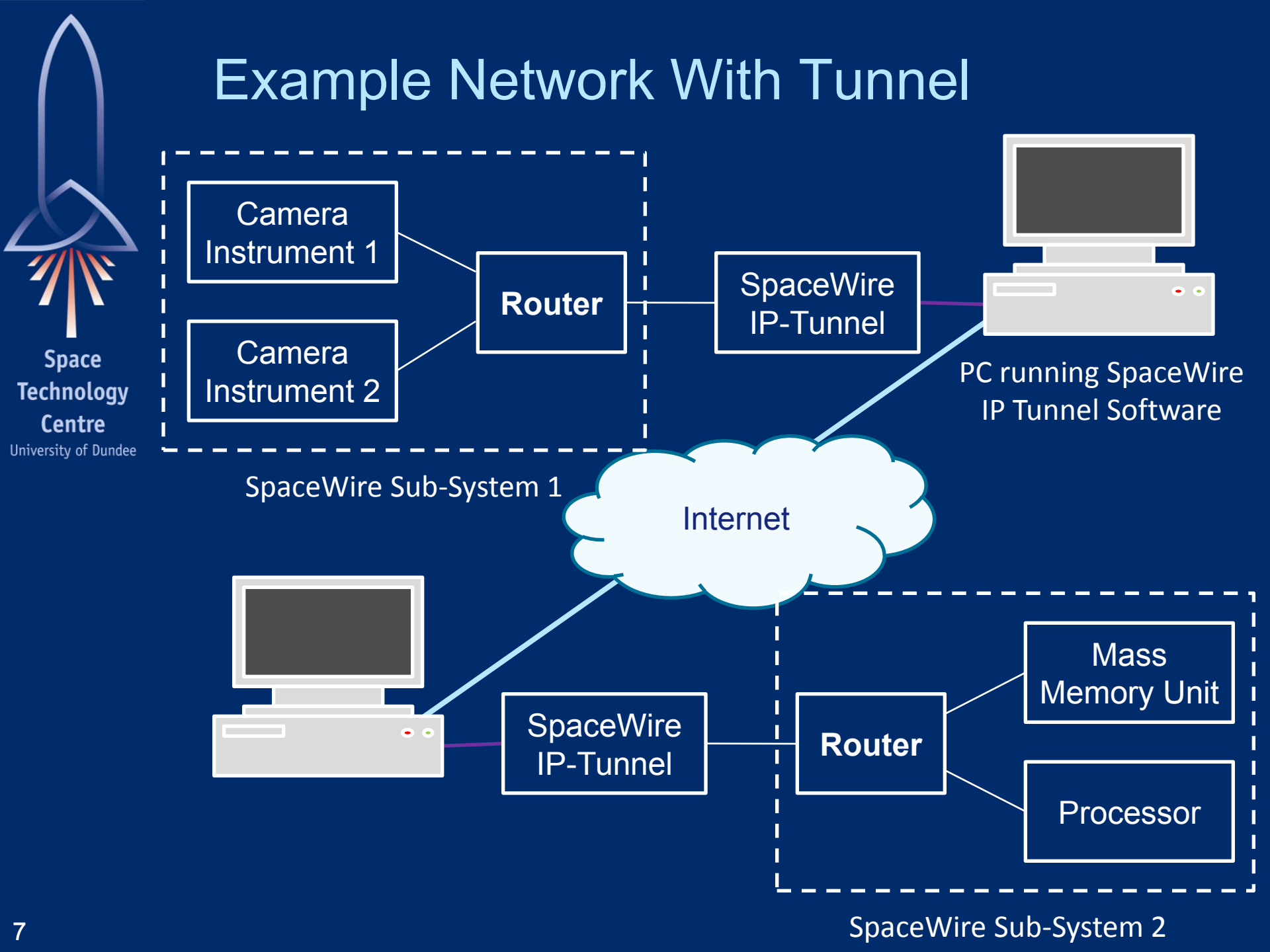
Example Network With Tunnel



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SpaceWire IP-Tunnel Hardware

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SpaceWire IP-Tunnel Hardware

- Modified STAR-Dundee SpaceWire-USB Brick
- Must not treat time-codes with higher priority, or drop out of sequence time-codes
- Must maintain the order of:
  - Time-codes
  - Data characters
  - Link start events
  - Disconnect events
- Must also provide features to avoid time-outs at routers due to reduced bandwidth and increased latency of Internet

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SpaceWire IP Tunnel Software

- Software written in Java
  - Cross platform, but dependant on available device drivers
- SpaceWire USB Driver
  - Available for Windows and Linux
  - Updated to support Tunnel hardware
  - Modified to maintain order of time-codes with data characters
  - Also passes up link start and disconnect events to the application
  - Performance improvements made to support unusual characteristics of traffic generated by Tunnel

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SpaceWire IP Tunnel Software

- Establishes secure connection between Tunnel users
  - Ensures traffic cannot be viewed or modified
  - Passwords can also be used to ensure the other user is who they claim to be
- Uses PC's network interface
  - E.g. Ethernet, Modem, …
- Traffic received from the device is sent over the network/Internet to the connected user
- Traffic received from the network is sent over the SpaceWire link
- Order of characters and events maintained at all times

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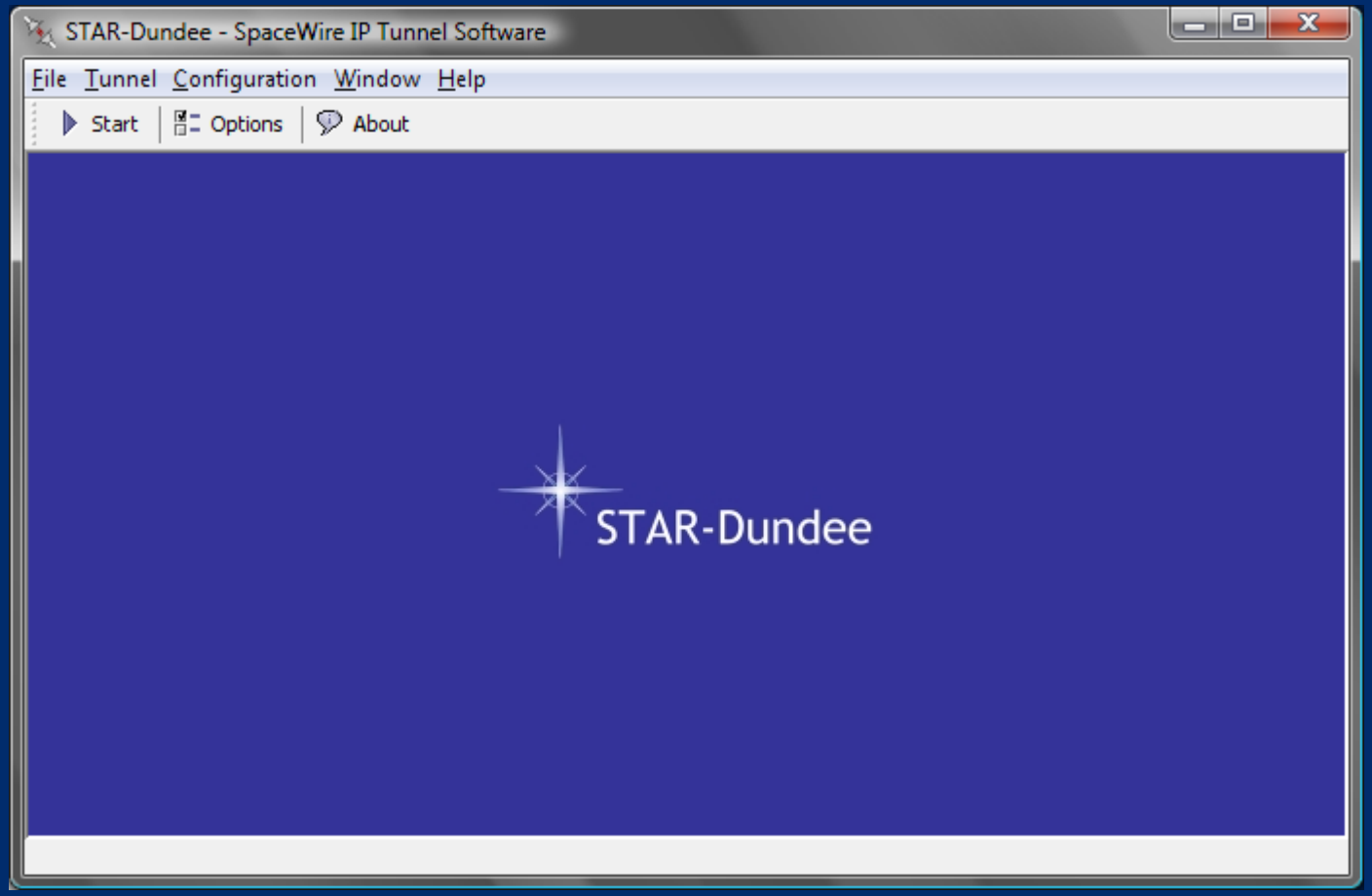
SpaceWire IP Tunnel Software



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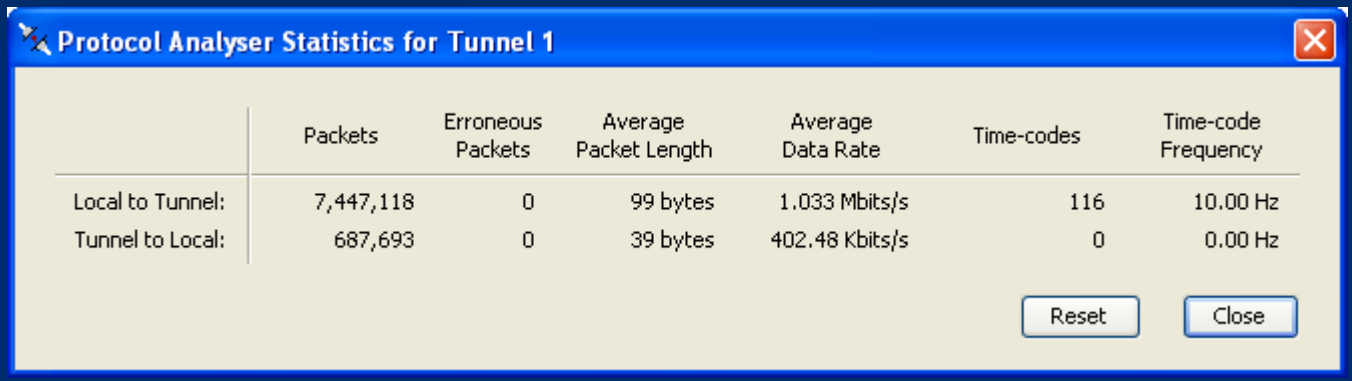
SpaceWire Protocol Analyser

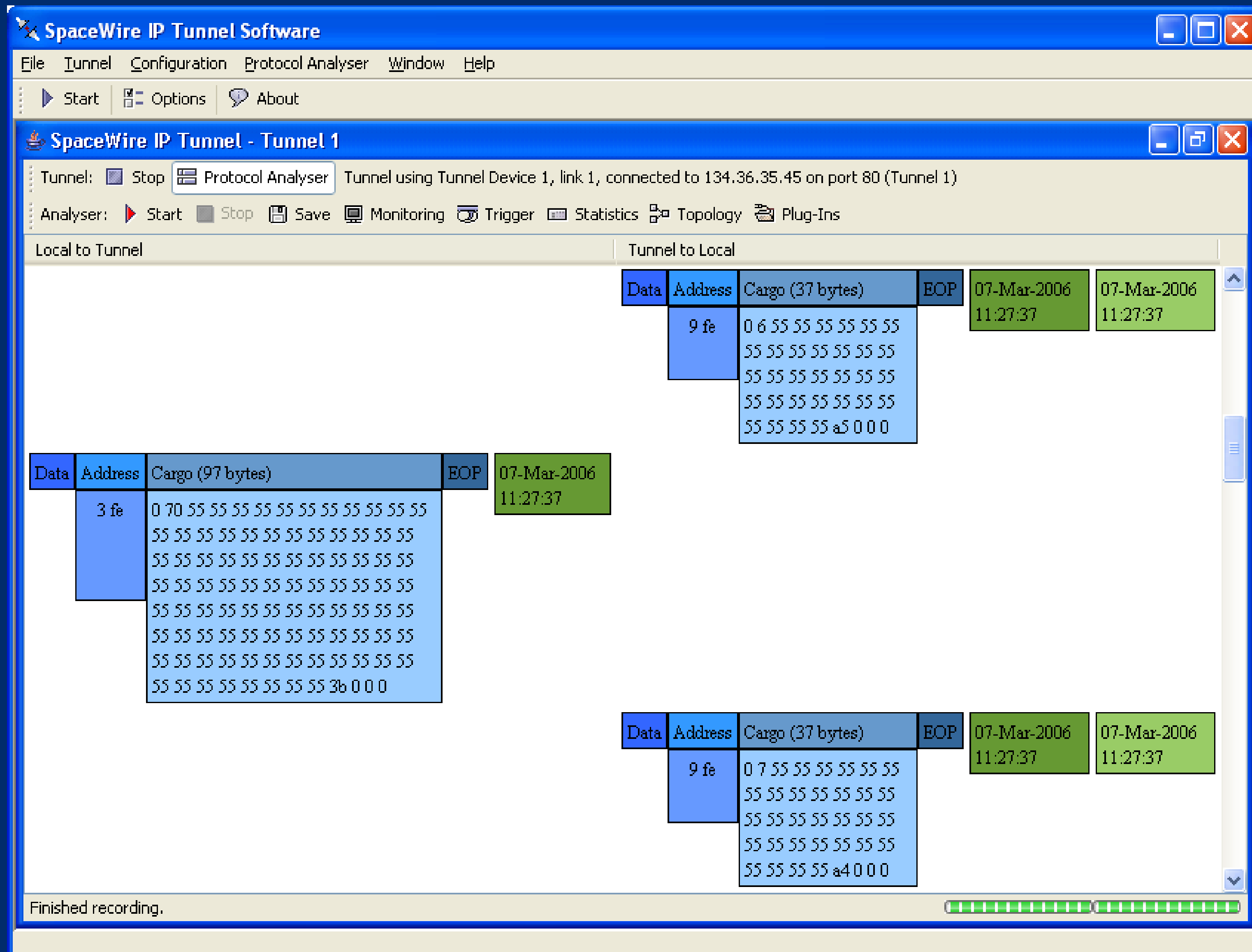
- Important to be able to debug any problems encountered by the software and hardware under test
- Protocol Analyser module integrated into the Tunnel Software
- Allows statistics of traffic to be monitored in real time



SpaceWire Protocol Analyser

- Traffic can be recorded
- Specify characteristics of traffic to record
  - e.g. data packets with specific addresses or time-codes with particular flag values)
- Also specify the traffic to trigger on
  - Similar options to the traffic to record
- And the amount of traffic to record before and after the trigger point
  - All traffic is recorded on the PC, so limited only by the memory and hard disk space of the PC
- Time that traffic enters and exits the Tunnel can also be recorded
  - NTP used to synchronise applications at each end

SpaceWire Protocol Analyser



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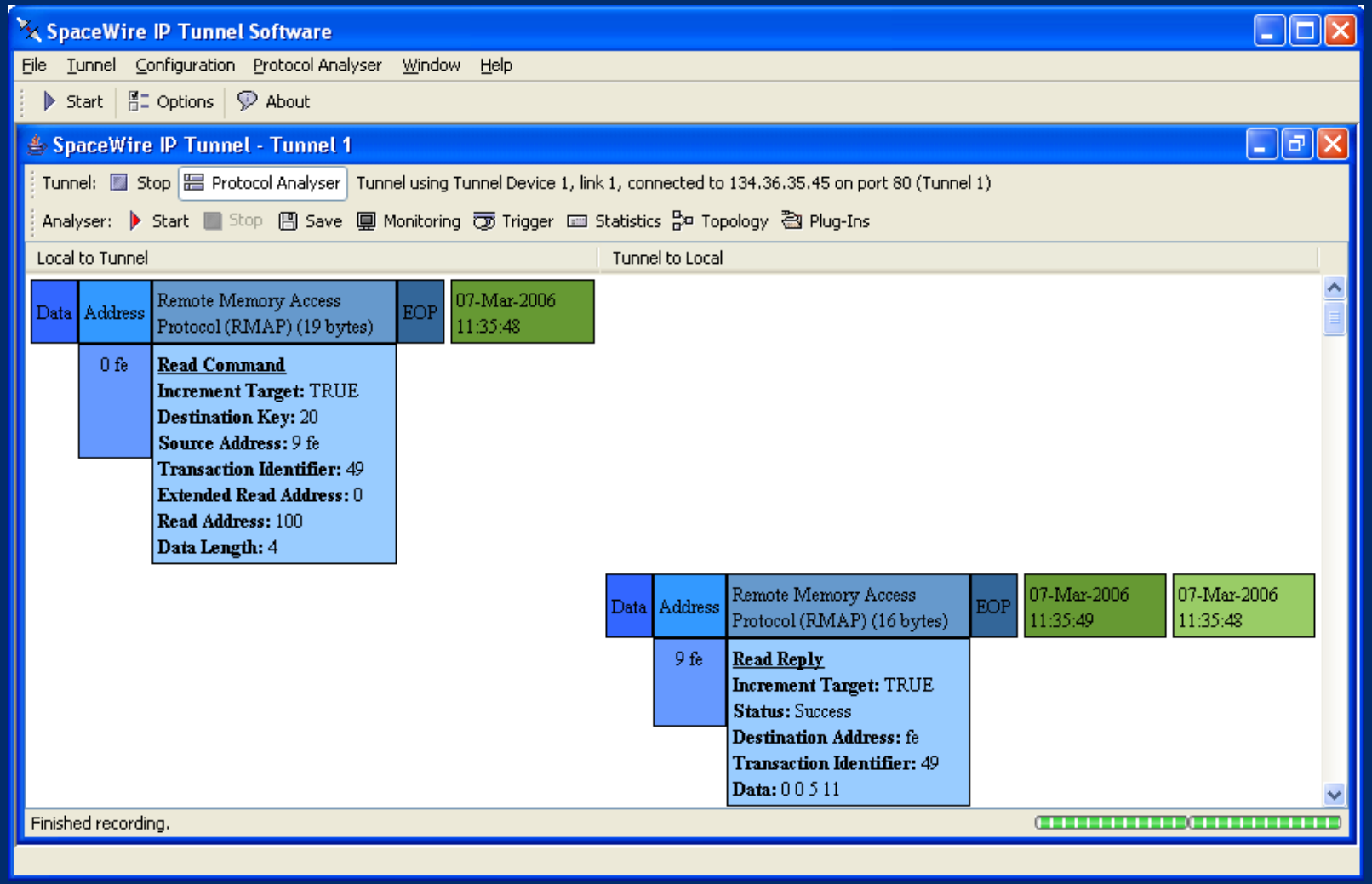
Higher Layer Protocol Plug-Ins

- Protocol Analyser supports concept of plug-ins
- Can be written by users and loaded by the application
- Specify the characteristics of a protocol
  - e.g. Protocol ID
- And how that protocol is displayed
  - e.g. show the values of specific fields
- Written in Java and can be very simple
- Formatting performed using HTML

Higher Layer Protocol Plug-Ins

- Once plug-in loaded, Protocol Analyser can:
  - Trigger when a plug-in's protocol is encountered
  - Record or trigger on traffic containing only that protocol
  - Record or trigger on traffic containing particular field values
- Recorded traffic containing protocol is formatted by the plug-in
- Example plug-in source code provided
- RMAP implementation also provided

Higher Layer Protocol Plug-Ins



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Pilot Activity

- ESA pilot study to test suitability of virtual satellite integration and the SpaceWire Internet Tunnel
- A number of organisations in numerous countries involved
- Performing experiments using the Tunnel
- Will report back on their results and experiences
- Tunnels between University of Dundee and organisations involved successfully tested

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SpaceWire Internet Tunnel Server

- Client-server architecture used by Tunnel application
  - One end must act as a server listening for connections from the other end (the client)
- Server end requires the same privileges as a web server for example
- Not permitted by many network administrators!

SpaceWire Internet Tunnel Server

- Tunnel Server will address this problem by providing a server to which both ends connect
- Traffic received from one client will be routed to the other
- Server will still require the same permissions, but could be hosted externally and will support a number of Tunnels
- Currently being developed

SpaceWire Internet Tunnel Improvements

- Existing software performs virtual satellite integration as intended
- However, numerous enhancements could still be made:
  - Chat window for communication between users
  - Support for proxy servers
  - Improved facilities for viewing recorded traffic
  - Playback of recorded traffic
- These enhancements are currently being considered for implementation
  - Improvements to performance will also be made

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Summary

- SpaceWire Internet Tunnel is now a completed product available from STAR-Dundee
- Successfully demonstrated across Europe
- The pilot activity will provide valuable information
- The Tunnel Server and Tunnel Improvements will increase these capabilities

- ESA are currently providing a demonstration of the Tunnel in the foyer