SecuringDistributed Adaptation

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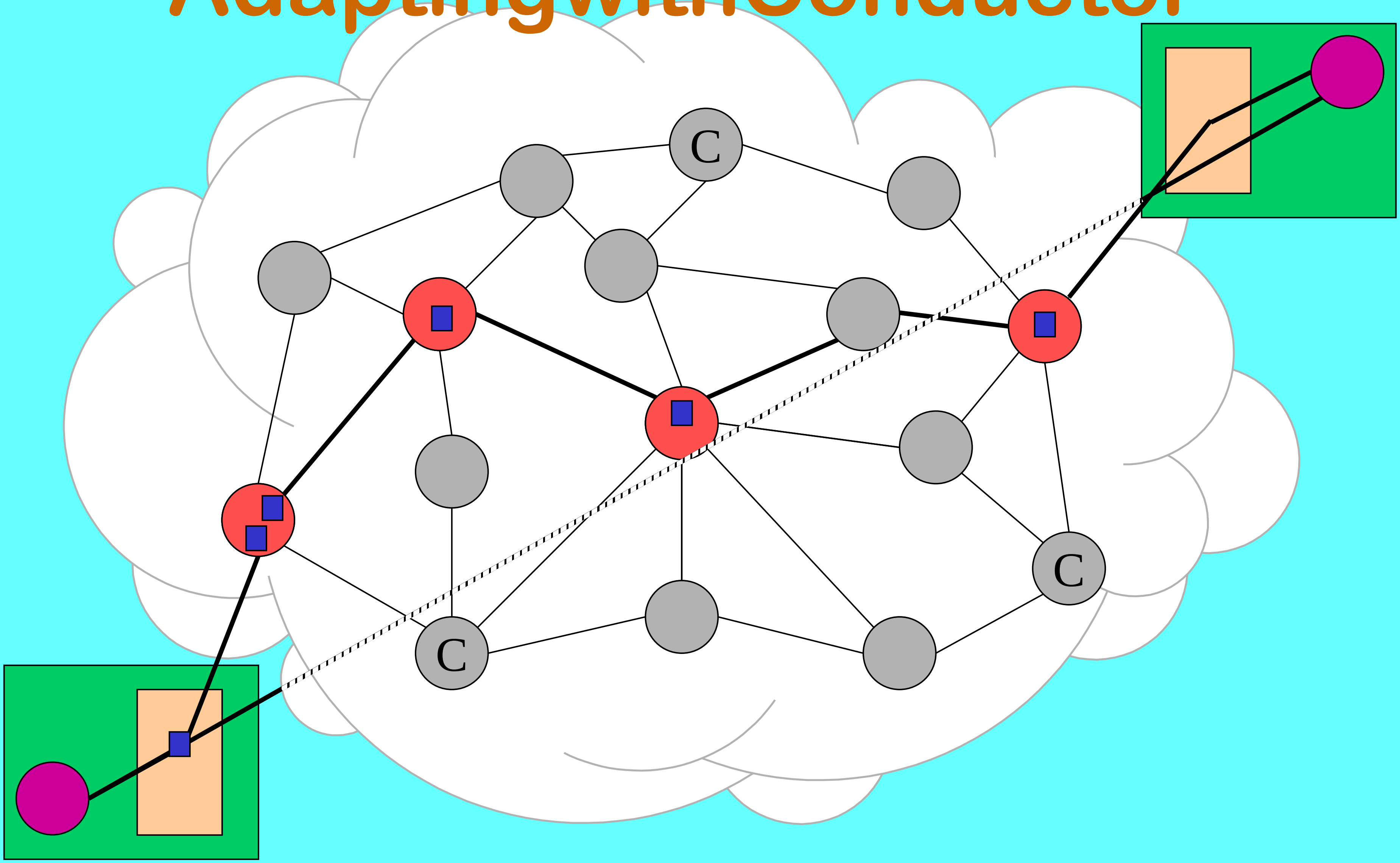
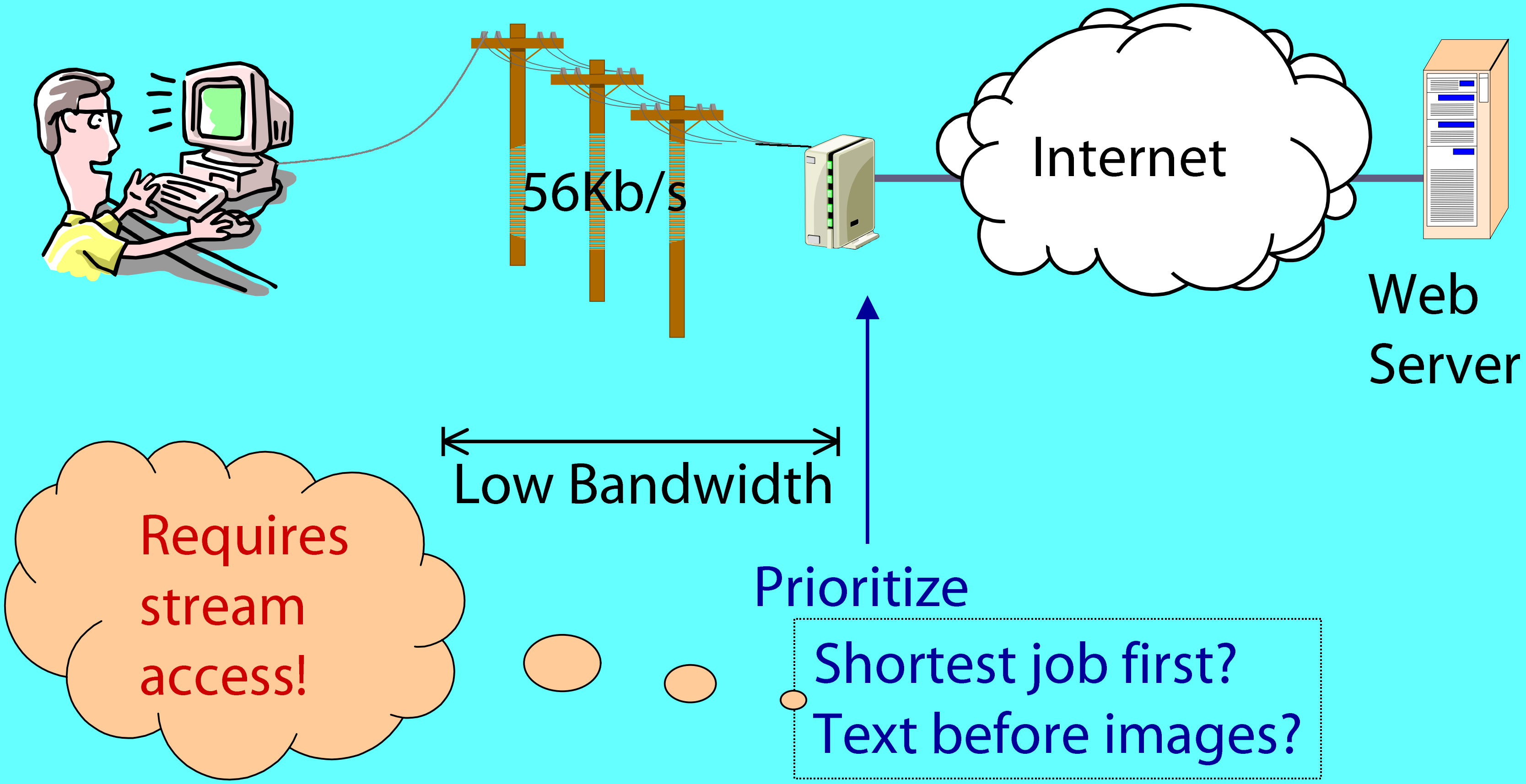
Presentation by: Mark Yarvis

AdaptingwithConductor



DistributedAdaptation



56Kb/s

Internet

Web Server

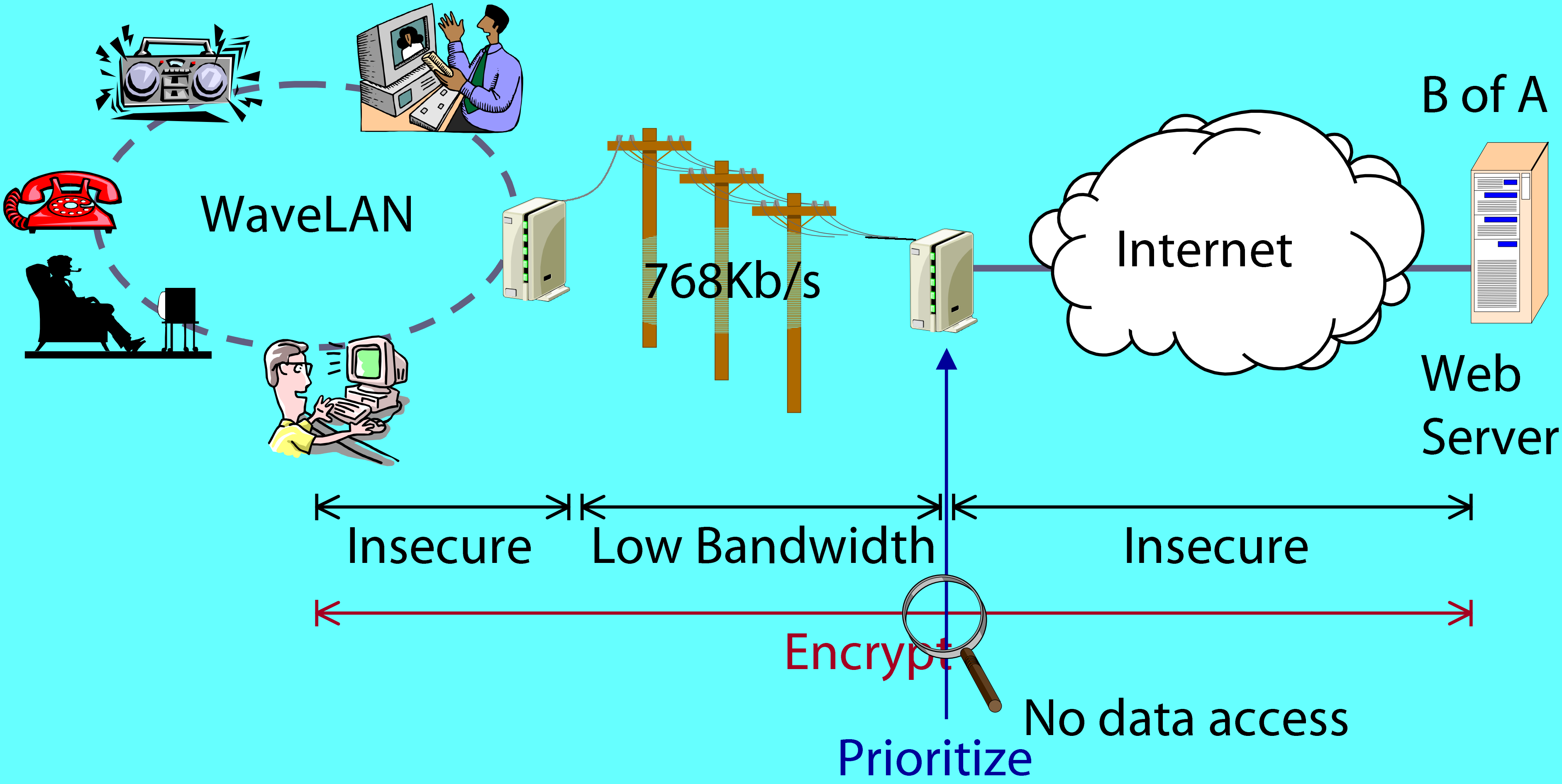
Low Bandwidth

Requires stream access!

Prioritize

Shortest job first?
Text before images?

DistributedAdaptation



B of A

WaveLAN

768Kb/s

Internet

Web Server

Insecure

Low Bandwidth

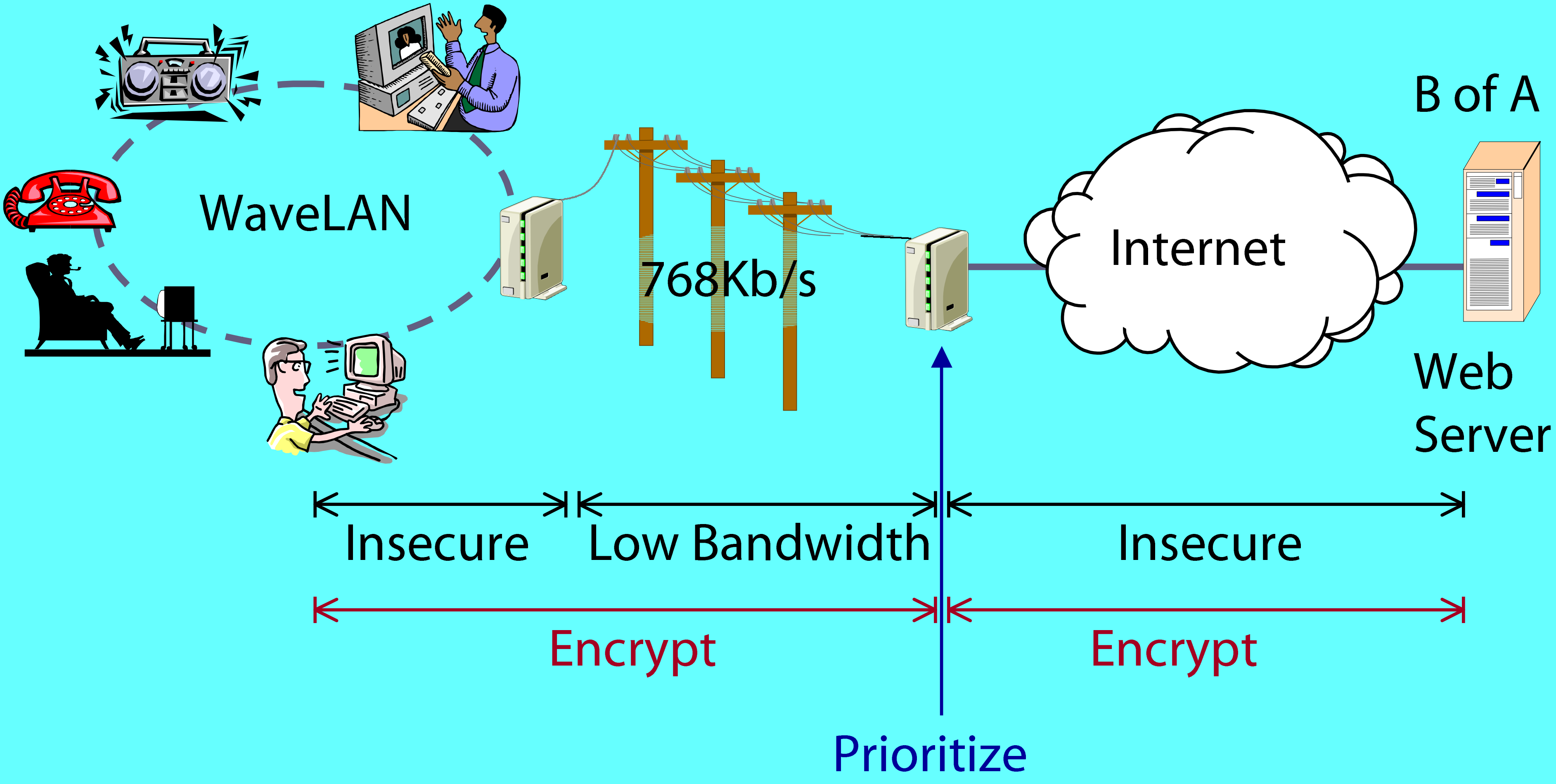
Insecure

Encrypt

No data access

Prioritize

DistributedAdaptation



WaveLAN

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B of A

Web Server

Insecure

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Encrypt

Encrypt

Prioritize

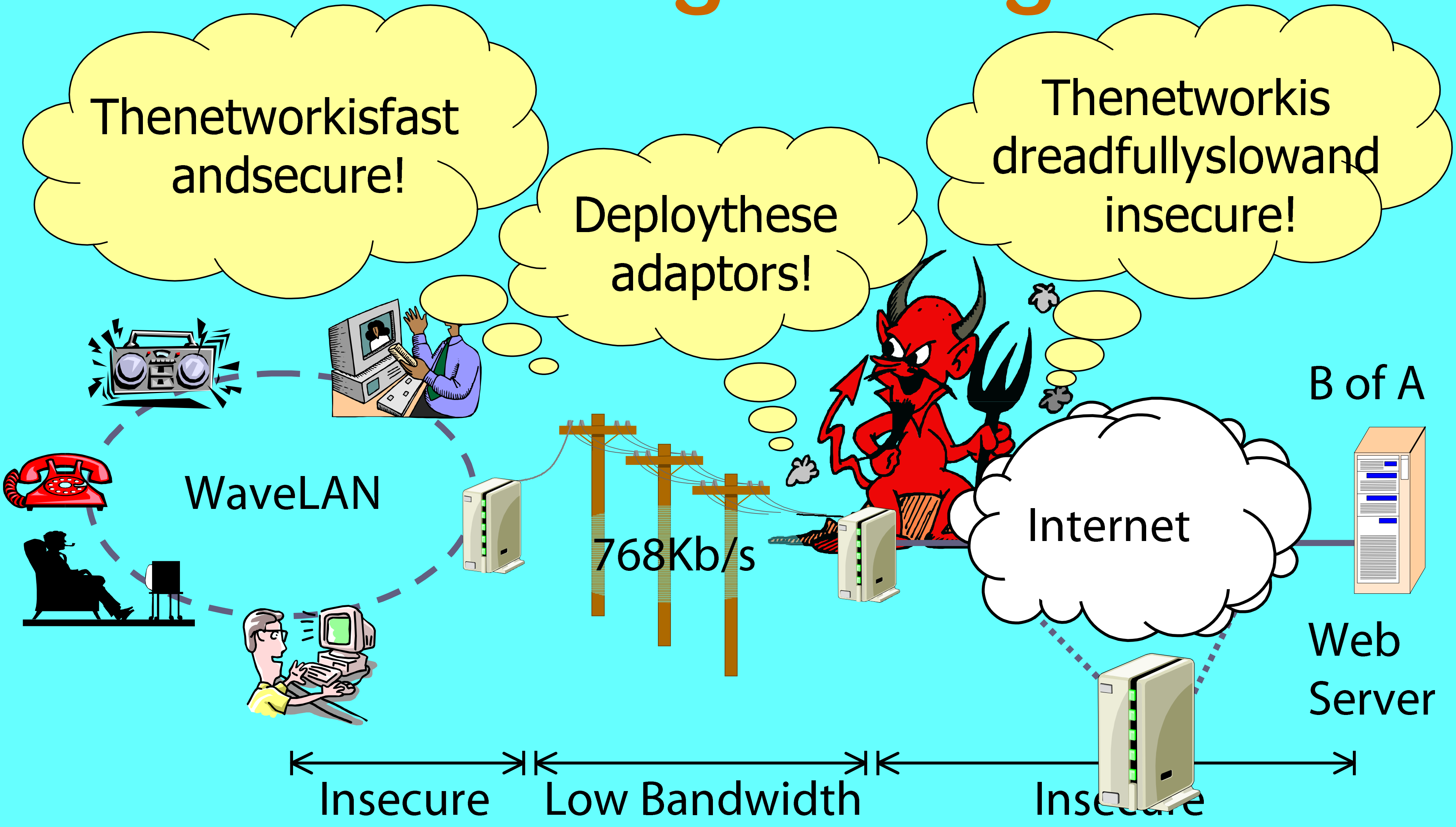
Characteristicsof Conductor

- Wide variety of possible adaptations
  - Compress, encrypt, prefetch
  - Distill a video stream to black-and-white
  - Remove and store e-mail attachments
  - Power down wireless interface during predicted query response latency
- Distributed planning architecture
  - Efficiently address end-to-end network conditions
  - Prevent adaptation conflicts
  - Security is needed to ensure adaptation is exactly as desired

Whatshouldbeprotected?

- Protect the secrecy and integrity of the user data
  - But, still allow adaptation
- Protect the nodes from misbehaving adaptors
  - Leverage existing research
- Protect the user from misbehaving nodes
  - Allow only desired adaptations

Whatcangowrong?



Thenetworkisfast andsecure!

Deploythese adaptors!

Thenetworkis dreadfullyslowand insecure!

WaveLAN

768Kb/s

Internet

B of A

Web Server

Insecure

Low Bandwidth

Insecure

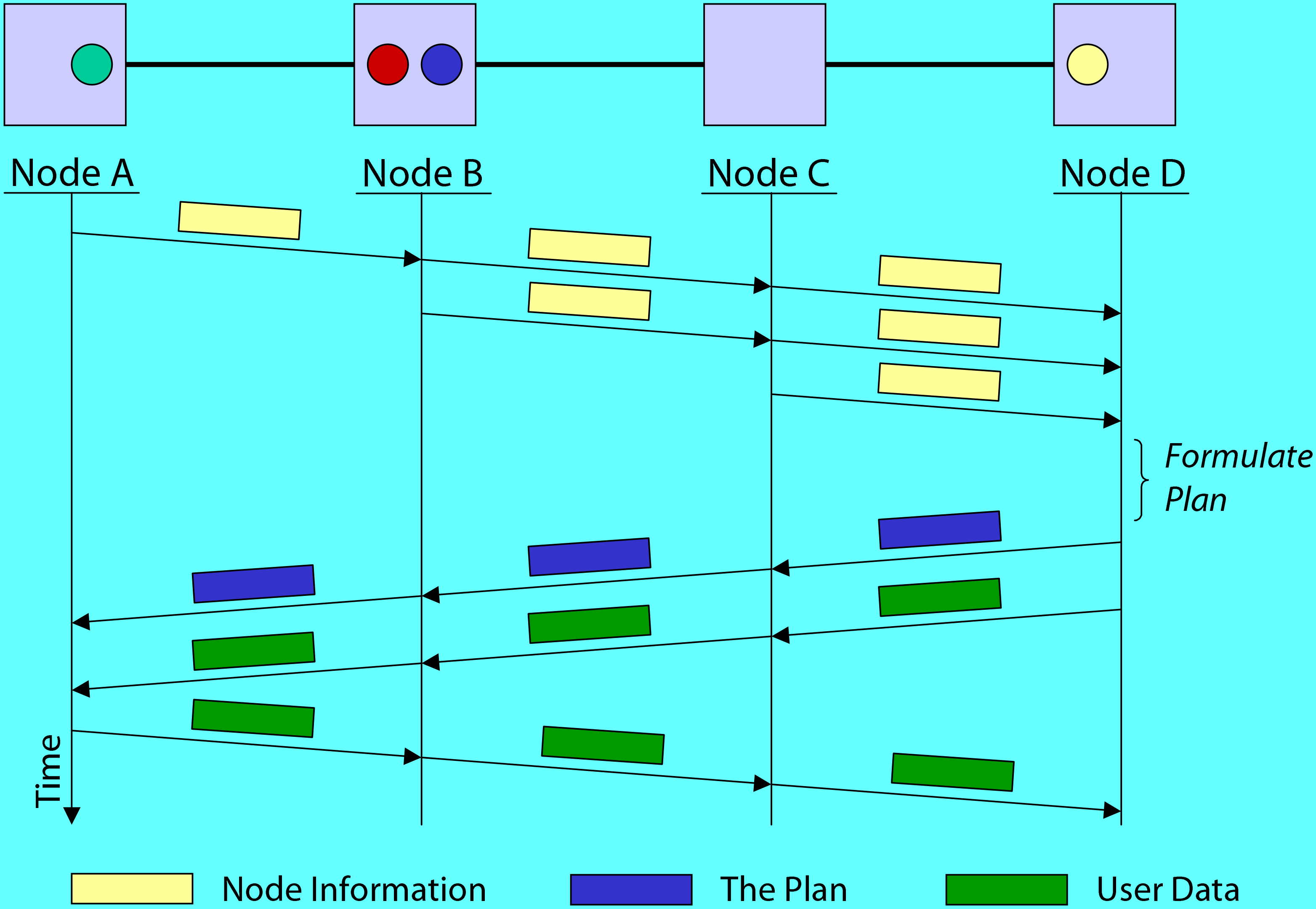
Whatnodescanwetrust?

- Various levels of trust possible
  - See or modify plain text
  - See or modify encrypted text
  - None
- Implicitly trust endpoints (typically)
- Trusting other nodes
  - Requires some type of authentication
  - Static list, dynamic trust model

Complicationsof DistributedAdaptation

- Users require different levels of security
- Adaptation may span administrative domains
  - No ubiquitous authentication infrastructure
  - Many choices; how do we agree securely?
- Must allow *limited* stream access within the network
  - Only desired adaptations
  - Typically restricted to trusted nodes

AdaptingwithConductor



Node A

Node B

Node C

Node D

Formulate Plan

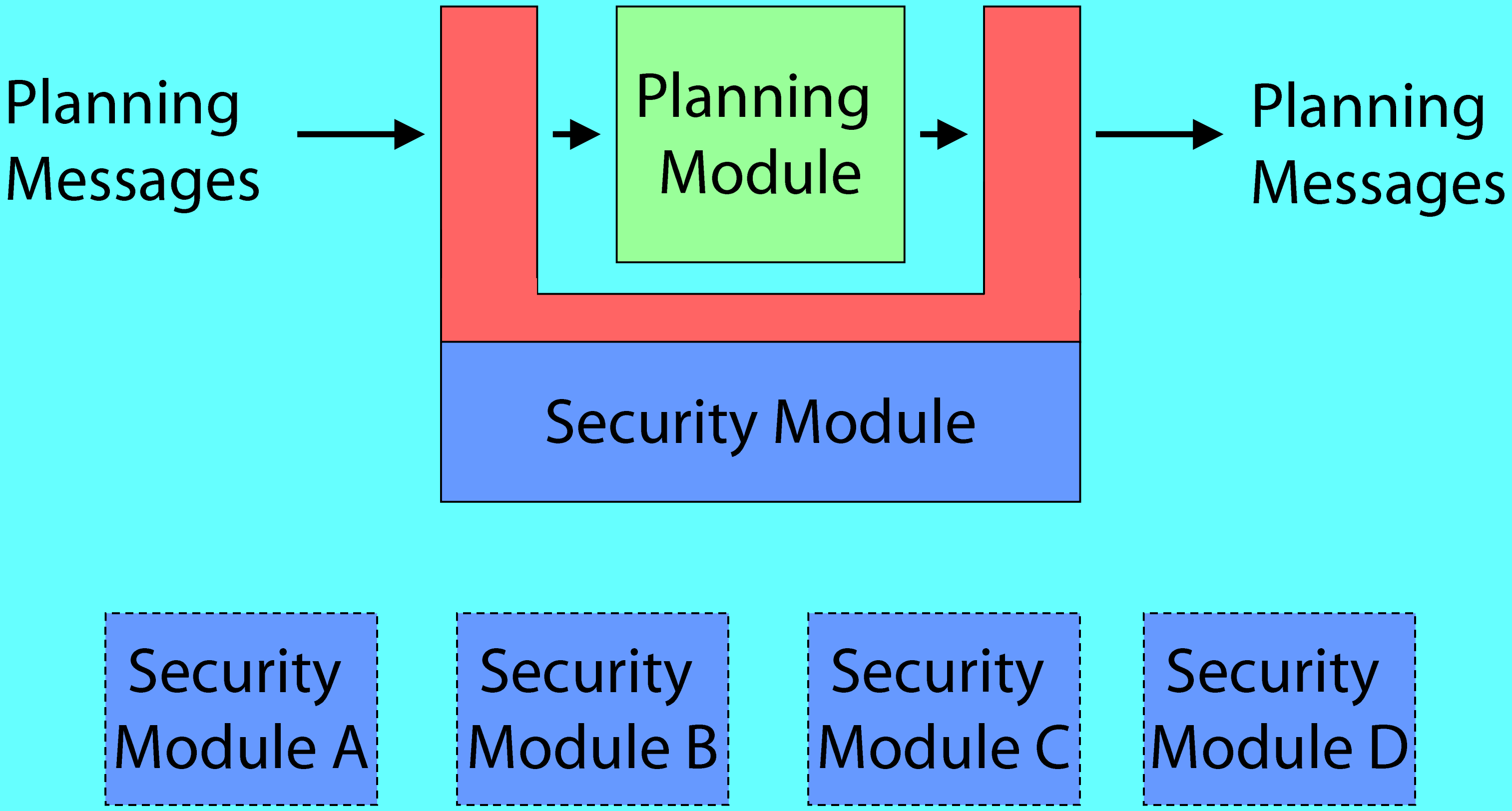
Time

🟨 Node Information 🟦 The Plan 🟩 User Data

SecurityinConductor

- Determine which nodes to trust
  - Select an authentication mechanism
  - Authenticate each node to the planner
  - Authenticate the planner to each node
- Protect planning from untrusted nodes
- Adapt plaintext only at trusted nodes
- Encrypt user data between trusted nodes

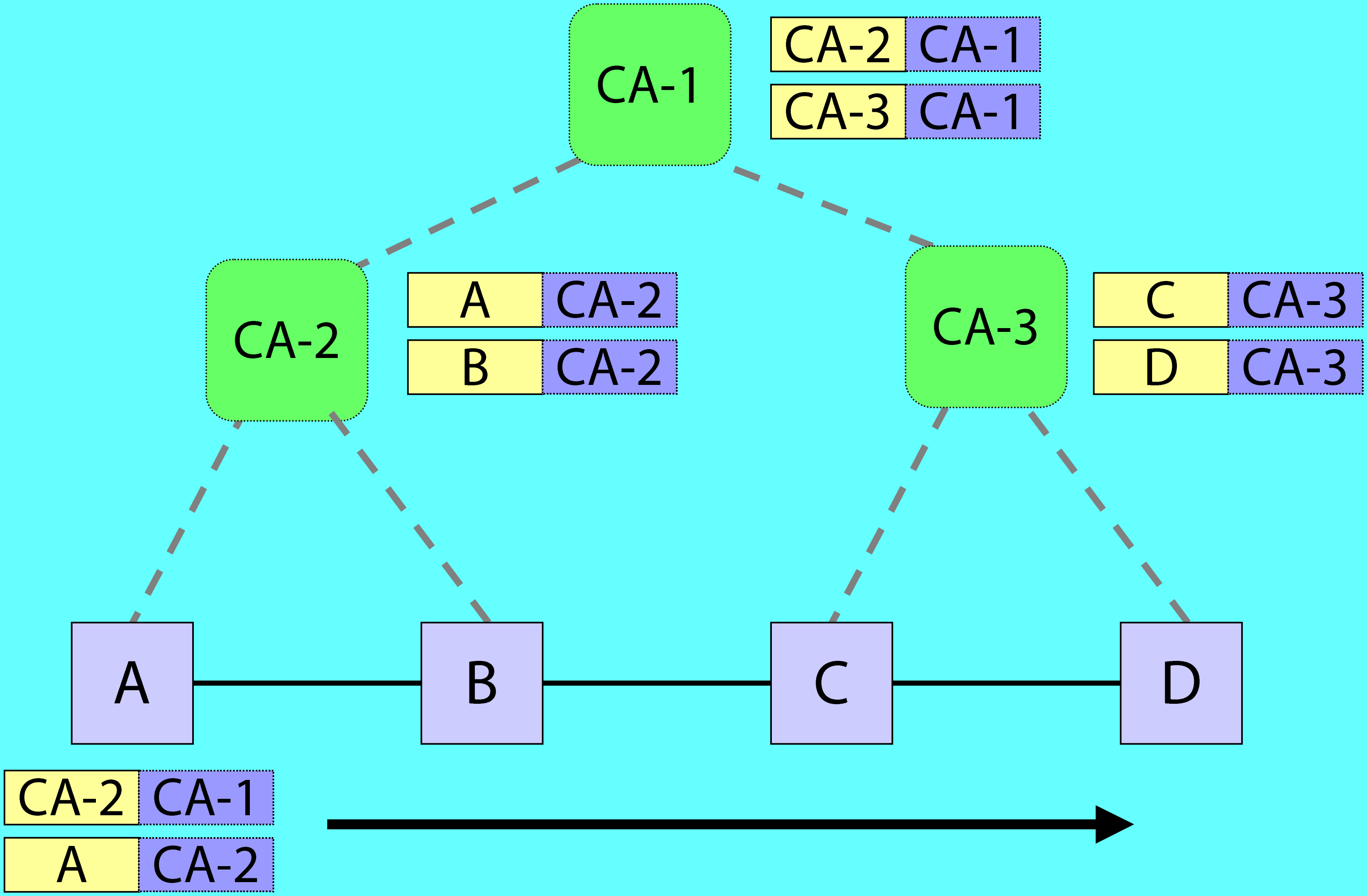
SecurityArchitecture



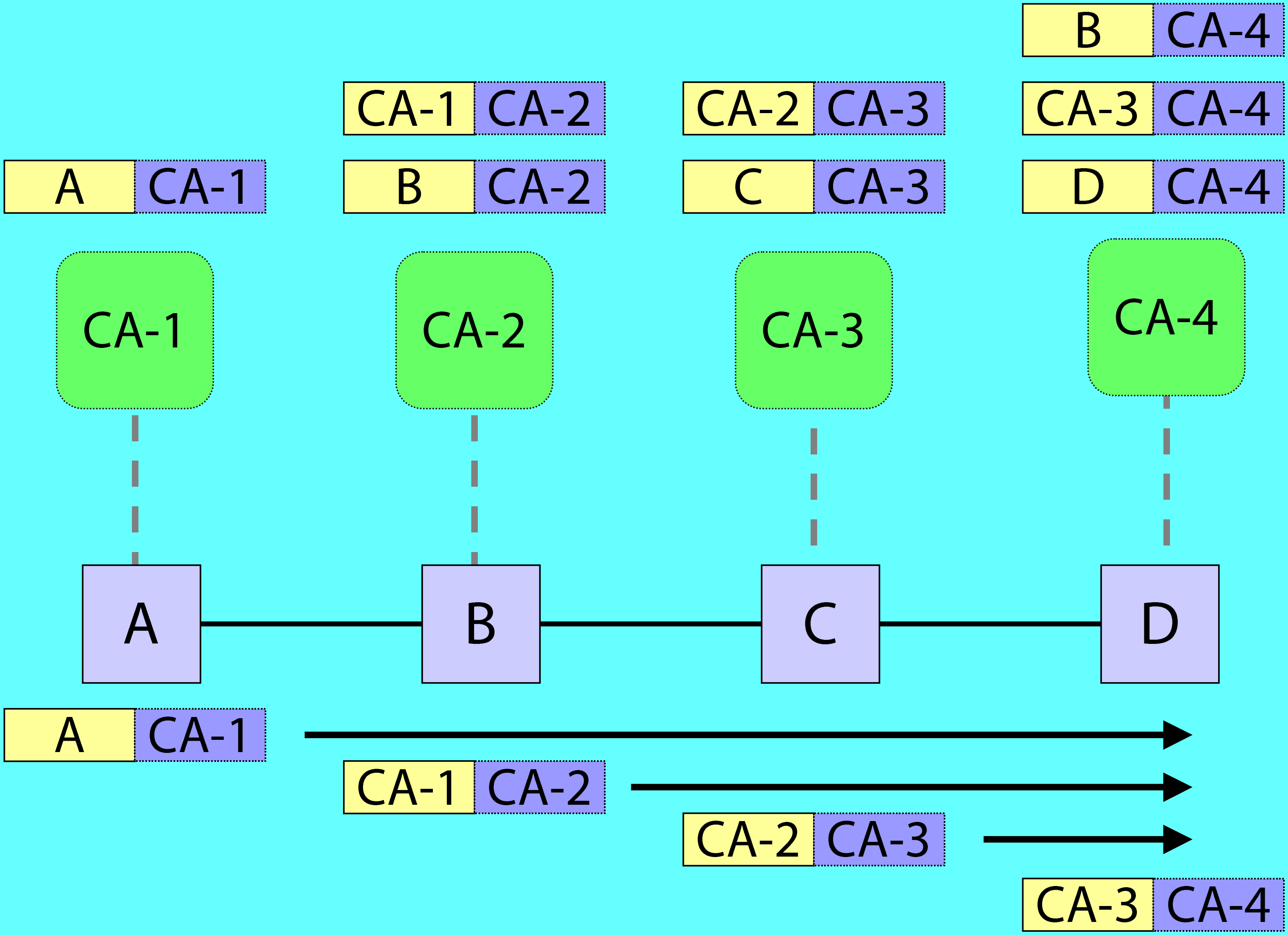
Authentication

- Goals:
  - Verifiable node identity
  - Digital signature capability
- Plug-in modules provide various authentication schemes
  - Null
  - Public-key based: tree, chain of trust
  - Kerberos based

Tree-basedAuthentication



Chain-of-trustAuthentication

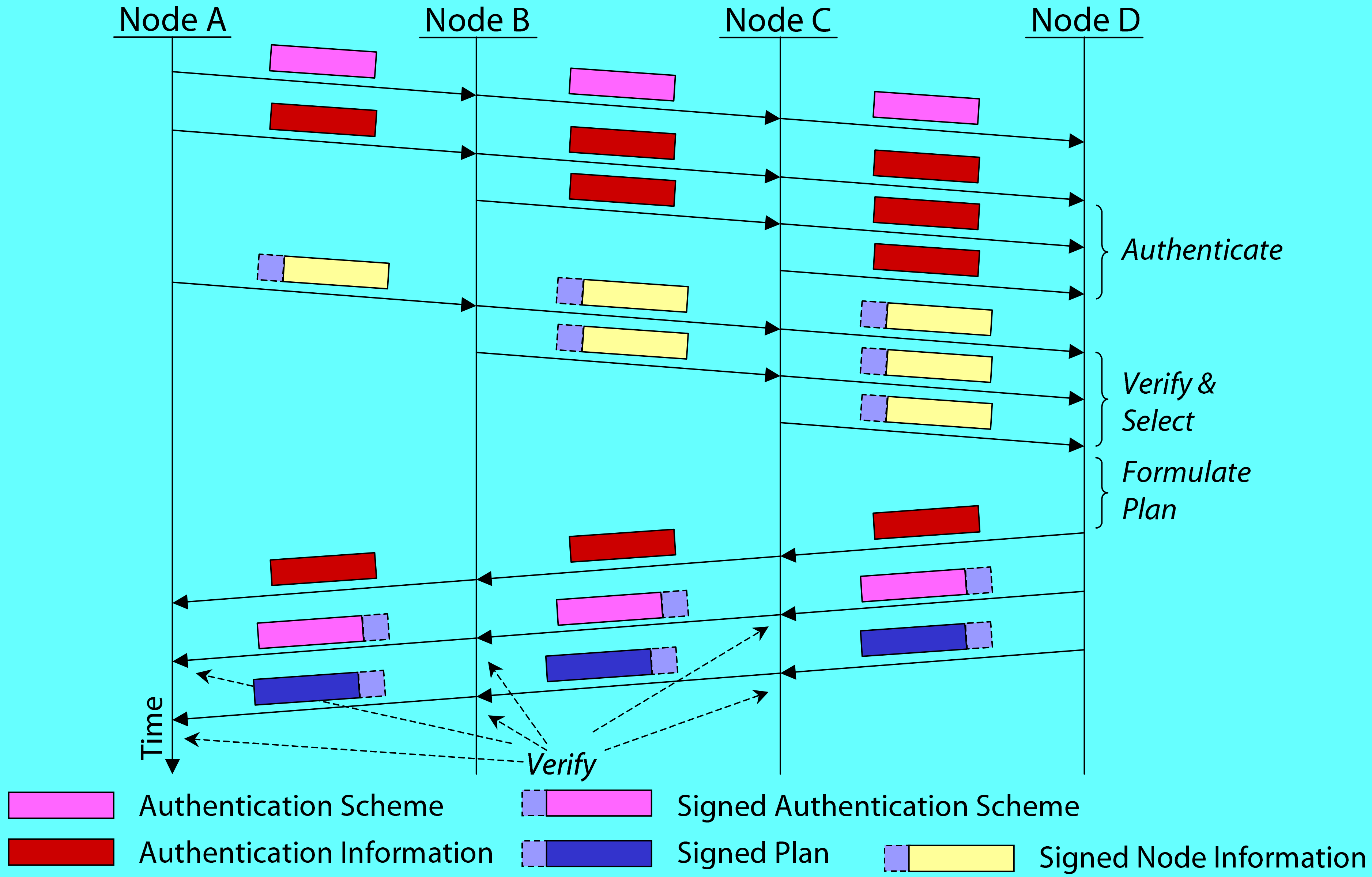


SelectinganAuthentication Scheme

- The client node selects the desired scheme

- Conductor must ensure that all nodes use the desired scheme
  - No external mechanism available
  - Nodes must not be fooled into using null security
  - Not sufficient for the client to sign its request

SecurePlanning



Node A

Node B

Node C

Node D

Authenticate

Verify & Select

Formulate Plan

Verify

Time

Authentication Scheme

Authentication Information

Signed Authentication Scheme

Signed Plan

Signed Node Information

SecurePlanning

- Protocol features
  - Ensures trusted nodes (and their planning information) can be identified
  - Ensures the specified authentication scheme was used by the planner
  - Ensures an authentic plan is distributed
  - Self selecting and self enforcing
- A random session id is used to prevent replay attacks
- Still required: protection for the user data …

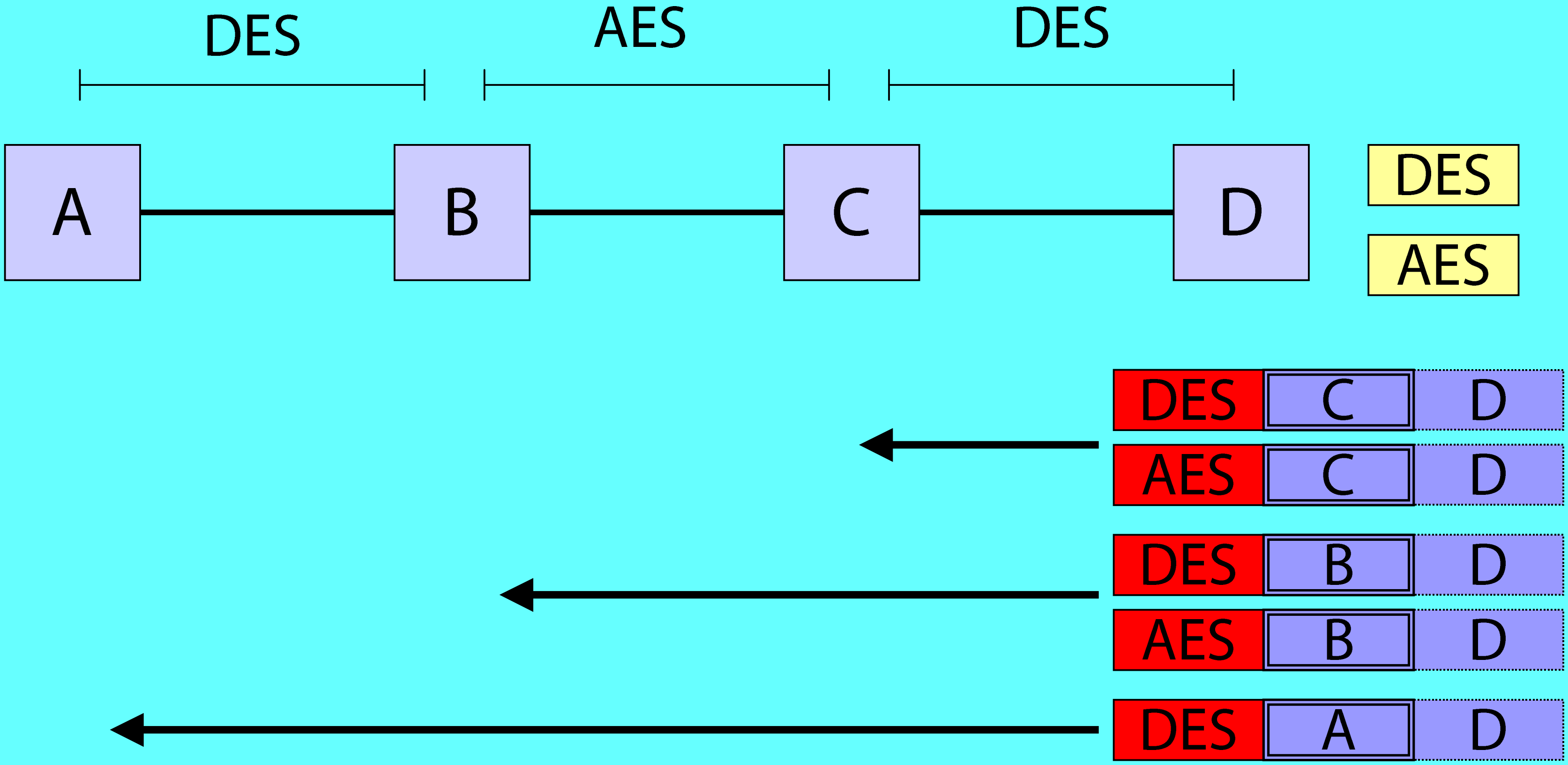
VirtualLinkEncryption

- Allow plaintext adaptation only at trusted nodes
- Encrypt between points of adaptation
  - Use encryption adaptors
- Requires:
  - Selection of trusted nodes
  - Encryption adaptor selection and deployment
  - Secure key distribution

SecureKeyDistribution

- Each deployed encryption adaptor requires a particular type of key
- Several keys may be required per session
  - Typically one of each type
- The planner uses adaptor code to generate a set of keys
- Each key is encrypted and signed for each recipient node
  - Use public/private key or shared secret from authentication

SecureKeyDistribution



Implementation

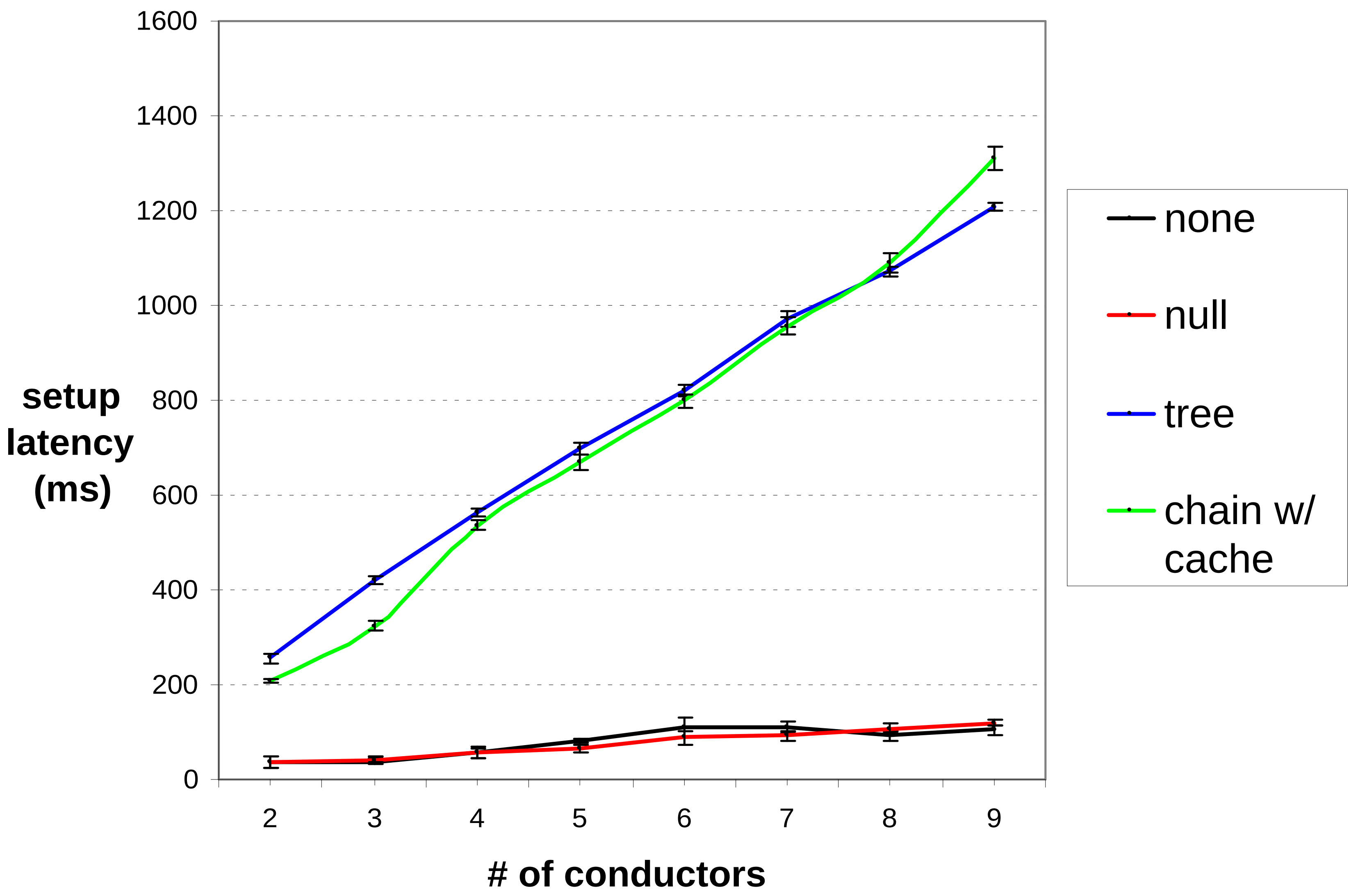
- Fully integrated into Conductor
- Security modules
  - Null
  - RSA/SHA-1: static, tree, chain-of-trust
- Encryption/decryption adaptors
  - DES
- Environment
  - Cryptix, Java, Linux

TheCostofSecure Planning

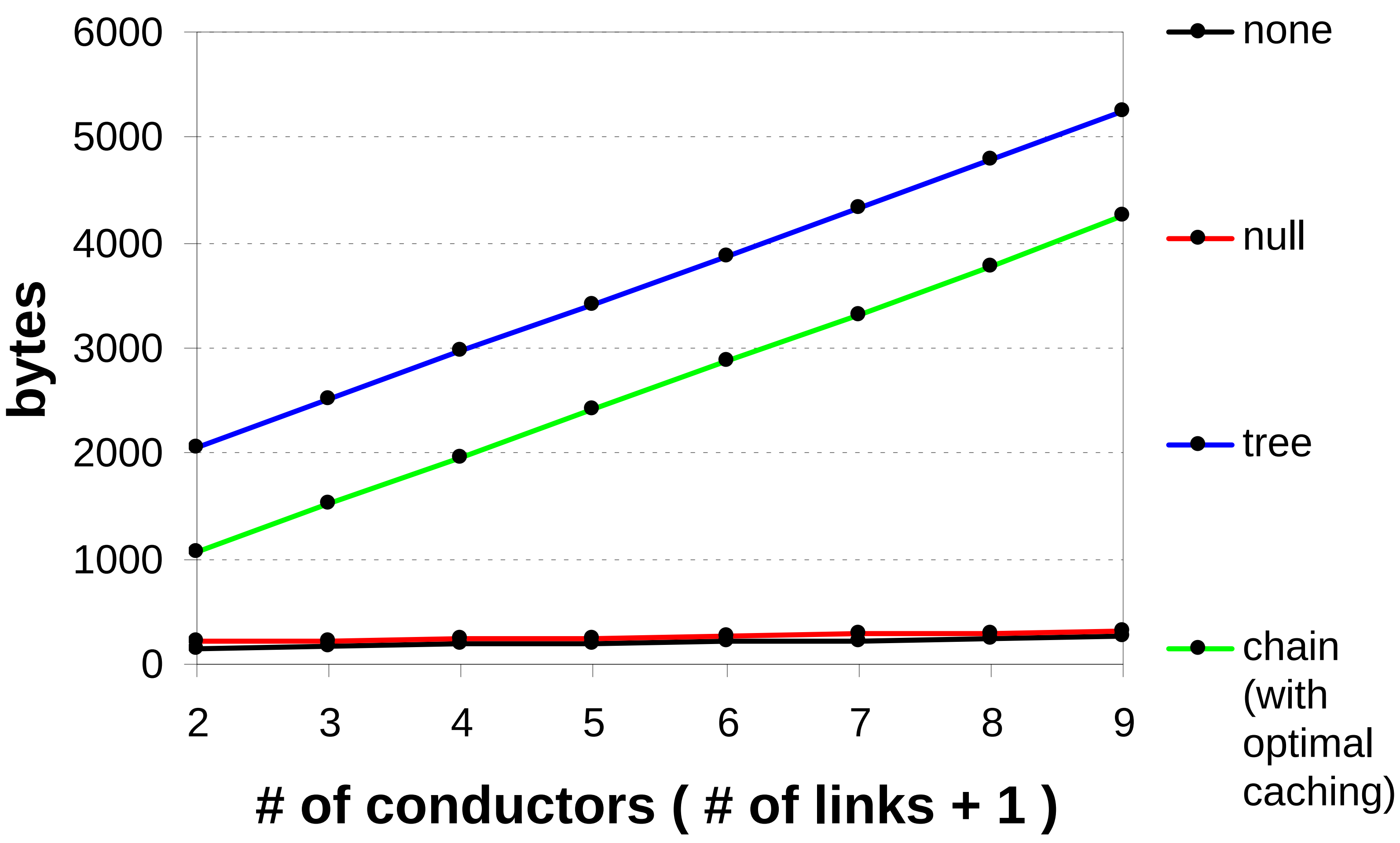
- Increased setup latency
- Increased bandwidth use

- Compare Conductor in four cases:
  - No security
  - Null authentication
  - Tree-based authentication
    - Tree height = 3
  - Chain-of-trust authentication
    - With maximum chain length

PlanSetupLatency



Bandwidth Used



Conclusion

- Adaptation is a powerful capability that introduces new avenues of attack
- Open architectures require comprehensive security
  - Protect the user data
  - Protect the node from malicious users
  - Protect the user from malicious nodes
- Conductor provides a flexible security mechanism for distributed adaptation