Conductor: Adapting with Agents

Mark Yarvis
Dr. Gerald Popek
Dr. Peter Reiber

Adaptation Goals

The Problem:
A wide variety of connectivity options are available, particularly for mobile users.
- Each has different levels of service
  - bandwidth, latency
  - security, cost, availability
- Mobile users may experience frequent service changes
  - Need to bridge gap between applications
- Applications require network capabilities
- Communication cost and latency

Solution:
Network applications typically expect a certain level of service and do not adapt gracefully.
- Need to bridge gap between applications
- Application requirements and network capabilities
- Communication cost and latency

Common choices:
- QoS: Application reserve required resources
  - Communication
- Adaptation: Either reduce application requirements or improve network capabilities

Adaptation is preferred when:
- The network is severely deficient
- The user can accept degraded service
- Upstream capabilities could be balanced (a network)

Examples:
- There are five basic types of adaptation:
  - data distribution, e.g., dynamic compression adaptive selection
  - predistribution, e.g., page bookkeeping
  - caching, e.g., dynamic by filtering
  - prioritization, e.g., ordered transmission in the application
  - protected extraction, allows more precise upstream

Other examples:
- Service-specific with transmission limitations
- Content-specific data compression
- Band-limited content, e.g., filtering
- Text access to a video conference
- Electronic, whiteboard with reduced consistency

Adaptors combine segments whenever cross-layer constraints allow.
- Use different protocols as combinations or segmentation

Approach:
- Application transparency
- Dynamic deployment
- Support for unique user requirements
- Application transparency
- Independent of individual connections
- Support for unique user requirements
- Application transparency
- Independent of individual connections

Adaptors combine segments whenever cross-layer constraints allow.
- Use different protocols as combinations or segmentation

Adaptation Architecture

Adaptor Modules
- Perform adaptations on data streams:
  - Segment creation:NdTo adapt inputs to specific outputs
  - Protocol conversion:
    - Domain-specific protocol configuration
    - Security protocol configuration
    - Protocol conversion:
      - e.g., dynamic ftp mirroring
      - e.g., ordered reconciliation in file replication
  - Adaptor modules communicate
    - Common points: adaptation discovery, availability, communication, data typing

Adaptors are independent:
- They can be coordinated, or
- They can be combined in a time-dependent manner

Adaptive streaming modifications are allowed:
- Distributed adaptor modules throughout connection

Combining Adaptor Modules
- Adaptors can be paired for transparent deployment:
  - The adapted stream is better suited for transmission
- Adaptors are independent:
  - They can be combined or removed

Adaptation Recovery
- Adaptors are independent:
  - They can be coordinated, or
  - They can be combined in a time-dependent manner

Reliability requirements:
- What to do with dependent data attributes (e.g., length):
  - Failures:
    - Stream failure
    - Node failure
    - Partition failure

Planning Algorithm:
- A node identifies a significant change in its state
  - It sends a local status to its predecessor
  - A request for planning is forwarded toward one endpoint
- A request for planning is forwarded toward one endpoint
  - A local plan is sent to it
  - Each node sends local status information to neighboring nodes
  - Planning is repeated
  - Information from all nodes is used to generate a new plan

Information Gathering Algorithm:
- Each node has a status:
  - A node identifies a significant change in its state
  - It sends a local status to its predecessor
  - A request for planning is forwarded toward one endpoint
  - A local plan is sent to it
  - Each node sends local status information to neighboring nodes
  - Planning is repeated
  - Information from all nodes is used to generate a new plan

Adaptation Planning
- Adaptation planning is dynamic: