Special Problems and Solutions for Multi-Task and Data Flow Control in High-performance Ground Processing System Based on Parallel Computing

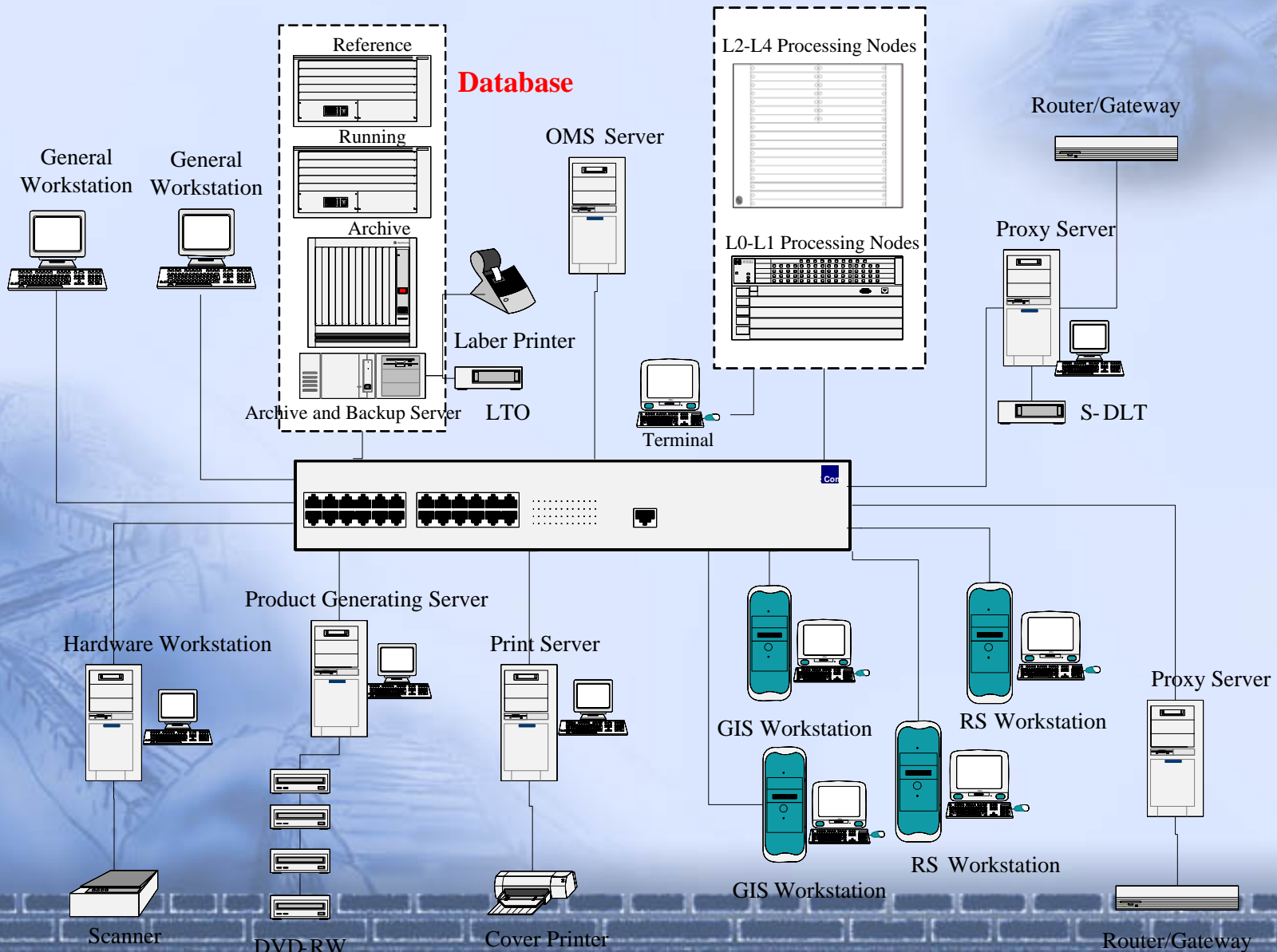Wanjun Zhang, Dingsheng Liu

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Outline

➢ Overview of GHIPS (High-performance Remote Sensing Satellite Ground Pre-processing System)

➢ Operation and Mission Subsystem (OMS)

➢ Crucial Problems and Solutions

❖ Management of Processing Workflow
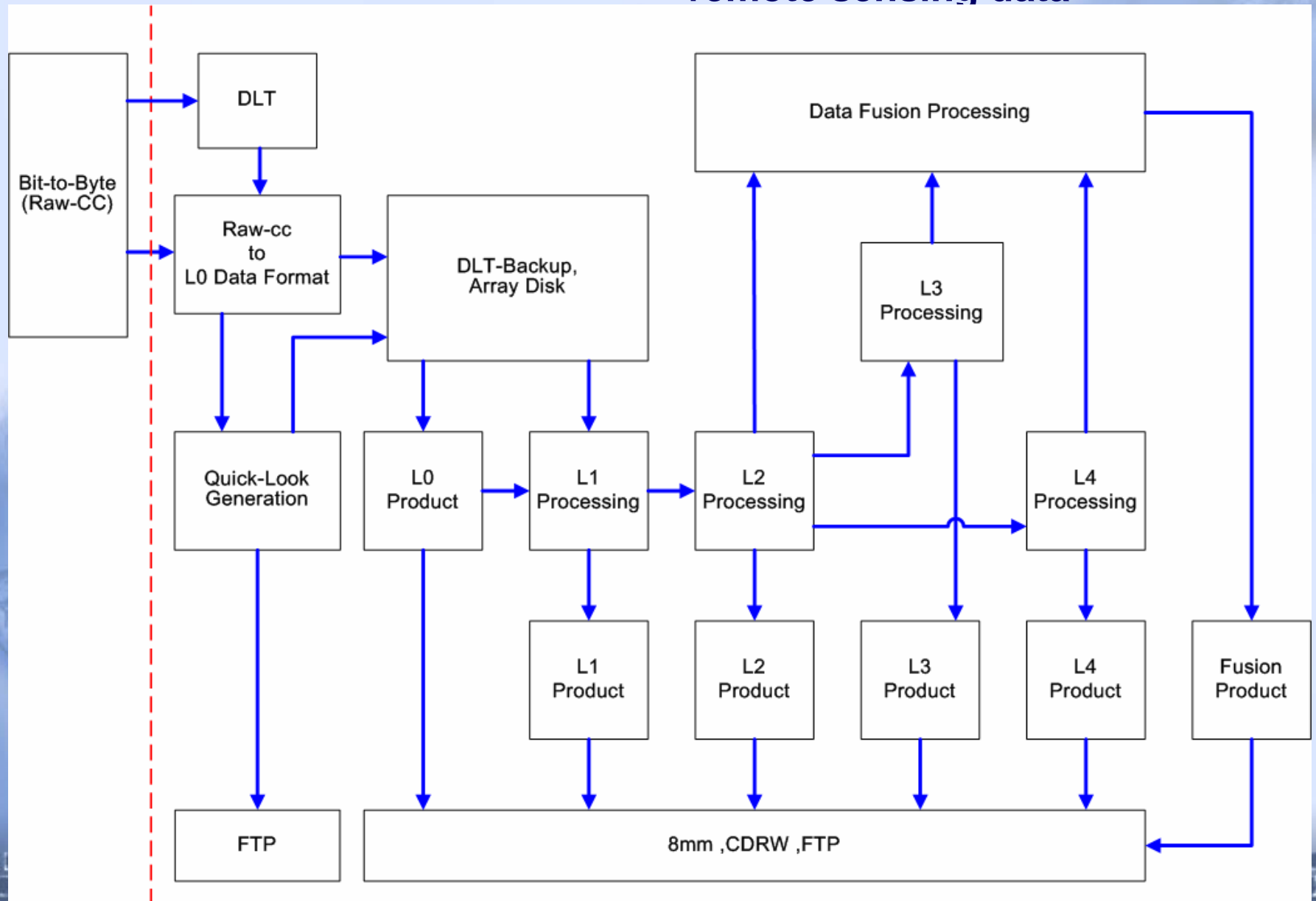
❖ Scheduling Strategies

➢ Results and Future Work

Overview of GHIPS

➤ **A multi-function system based on Cluster parallel processing system**

Cluster

Database

Reference

Running

Archive

Archive and Backup Server LTO

Laber Printer

OMS Server

General Workstation

General Workstation

L2-L4 Processing Nodes

L0-L1 Processing Nodes

Router/Gateway

Proxy Server

S-DLT

Terminal

Product Generating Server

Hardware Workstation

Print Server

GIS Workstation

RS Workstation

Proxy Server

GIS Workstation

RS Workstation

Scanner

DVD-RW

Cover Printer

Router/Gateway

3

➢ **A general preprocessing system for different satellite remote sensing data**

Overview of GHIPS (cont.)

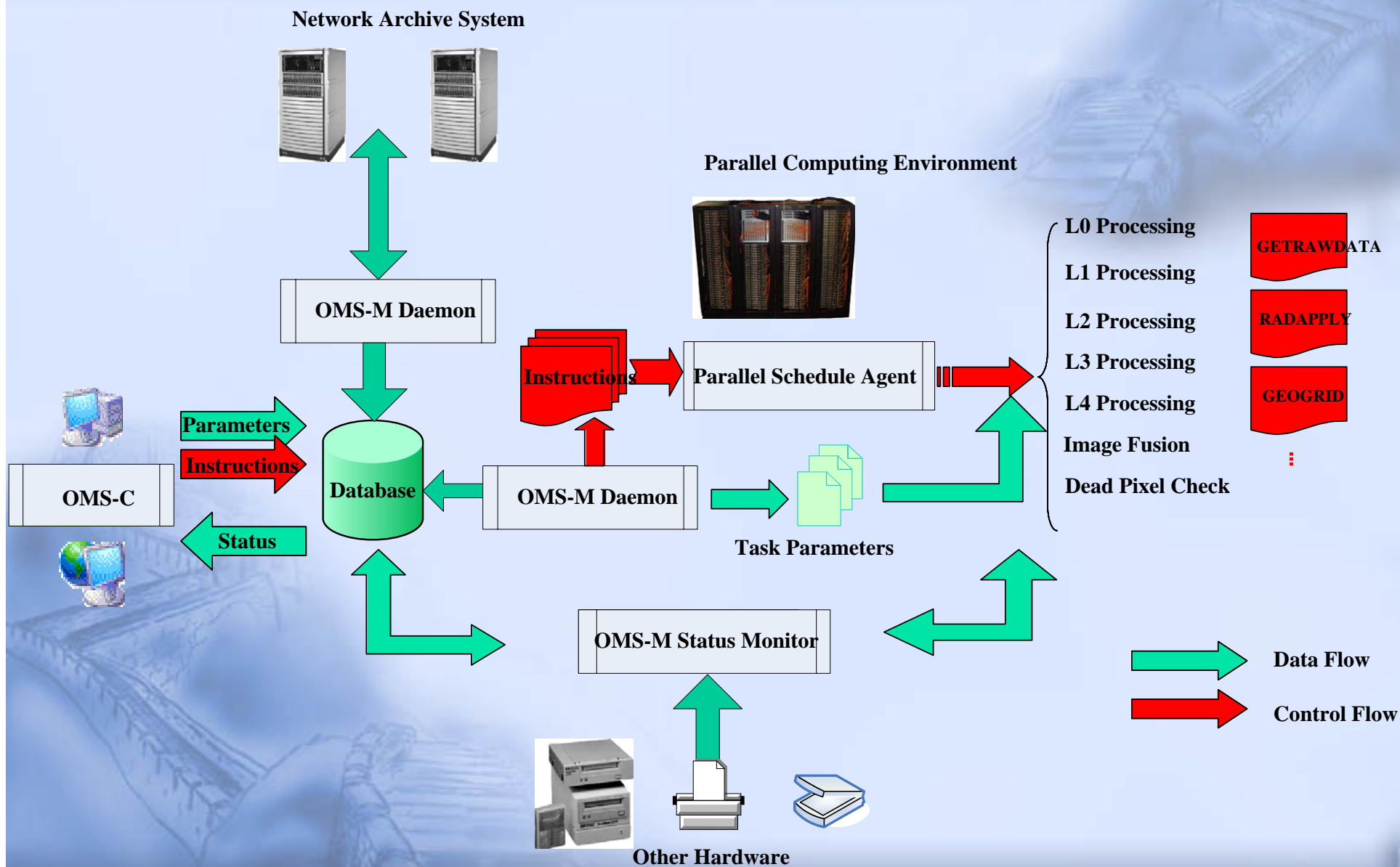➢ High performance, High throughput, Multi-user and Multi-product

Data Input	Size	Total Time	Average_Time/100MB
(50 Scenes) 6000*50000*3Bands	45GB	36 Mins 58 Secs	5.08 Secs
(16 Scenes) 6000*100000*3 Bands	28.8GB	24 Mins 48 Secs	3.22 Secs
(100 Scenes) 6000*16000*3Bands	30GB	20 Mins 17 Secs	6.76 Secs

➢ **Successful used as an operational processing system for BEIJING-1 (DMC+4)**

Operation and Mission Subsystem (OMS)

➢ Purpose: Task scheduling and central control of Multi-Task

➢ Feature: Interact with all of the other subsystems in GHIPS

➢ Missions:

❖ User Interface Management

❖ Task Scheduling and Process Control for Clusters

❖ User Authority Management

❖ Others: System configuration, etc.

➢ Structure -- Two Parts:

❖ OMS Master (OMS-M) – running at cluster side

❖ OMS Client (OMS-C) – running at client workstation

OMS Structure

Network Archive System

Parallel Computing Environment

OMS-M Daemon

Instructions → Parallel Schedule Agent

L0 Processing
L1 Processing
L2 Processing
L3 Processing
L4 Processing
Image Fusion
Dead Pixel Check

GETRAWDATA

RADAPPLY

GEOGRID

⋮

Parameters
Instructions

OMS-C

Database ← OMS-M Daemon

Status

Task Parameters

OMS-M Status Monitor

Other Hardware

Data Flow

Control Flow

Management of Processing Workflow

➤ Situation:

❖ Over 15 Products: L0, L1, …

❖ Diverse Algorithms: Registration, radiometric correction, geometric correction, orthograph, image fusion, …

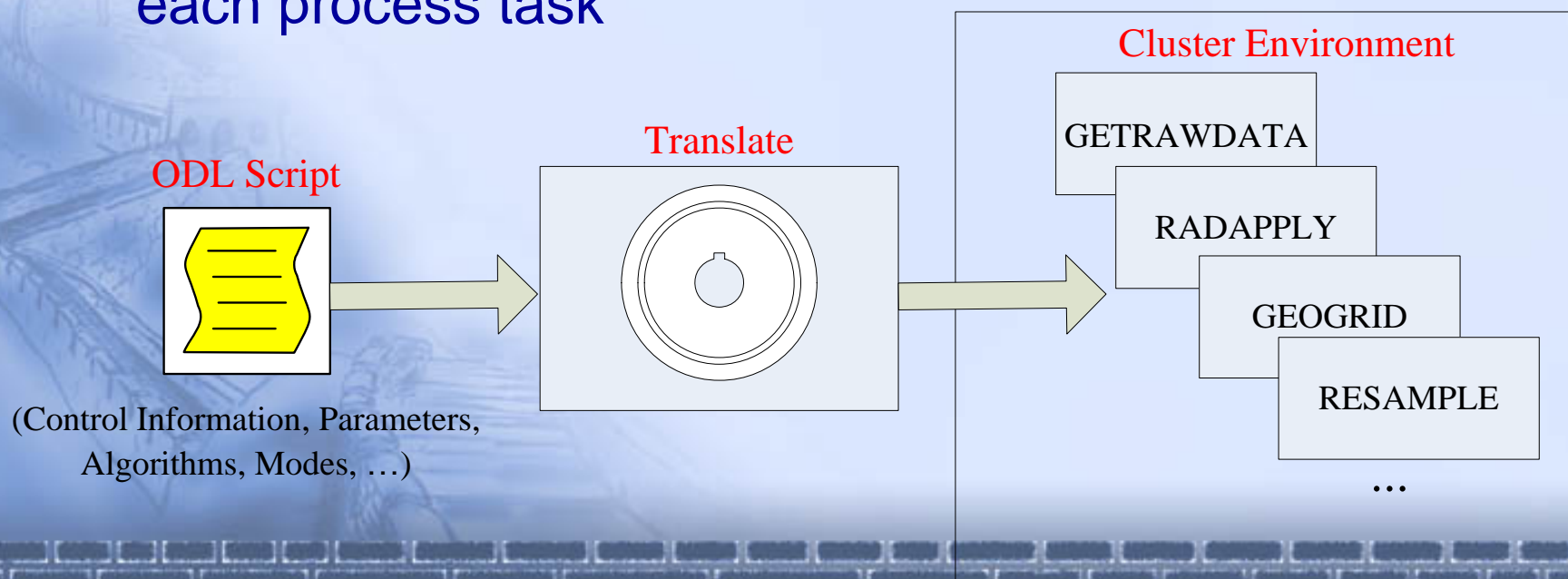❖ Parameter inputs: internal, external

❖ Processing Modes: Serial, Parallel

➤ Problems: How to flexibly organize the processing workflows.

❖ Manage the multi-task with diverse algorithms, data flow and scale in the parallel processing system

❖ New algorithms, new modes should be easily supported.

Management of Processing Workflow (cont.)

➢ Solution:

   ❖ Divided processing function into a serial of prototype process steps

   ❖ Describe the processing workflow through ODL (Object Define Language) Script

   ❖ OMS manages the ODL script to control activities of each process task

Cluster Environment

Translate

ODL Script

GETRAWDATA

RADAPPLY

GEOGRID

RESAMPLE

…

(Control Information, Parameters, Algorithms, Modes, …)

Management of Processing Workflow (cont.)

➢ Dynamical Control of Tasks status

  ❖ Status: cancel, hold, suspend or restart

Schedule Strategies

➢ Problems:

❖ How to control the process between clusters and user interface clients

- Clusters: Redhat Linux

- Clients: Windows XP

❖ How to make image data processing efficiently

- Massive remote sensing image

- Parallel processing based Cluster environment
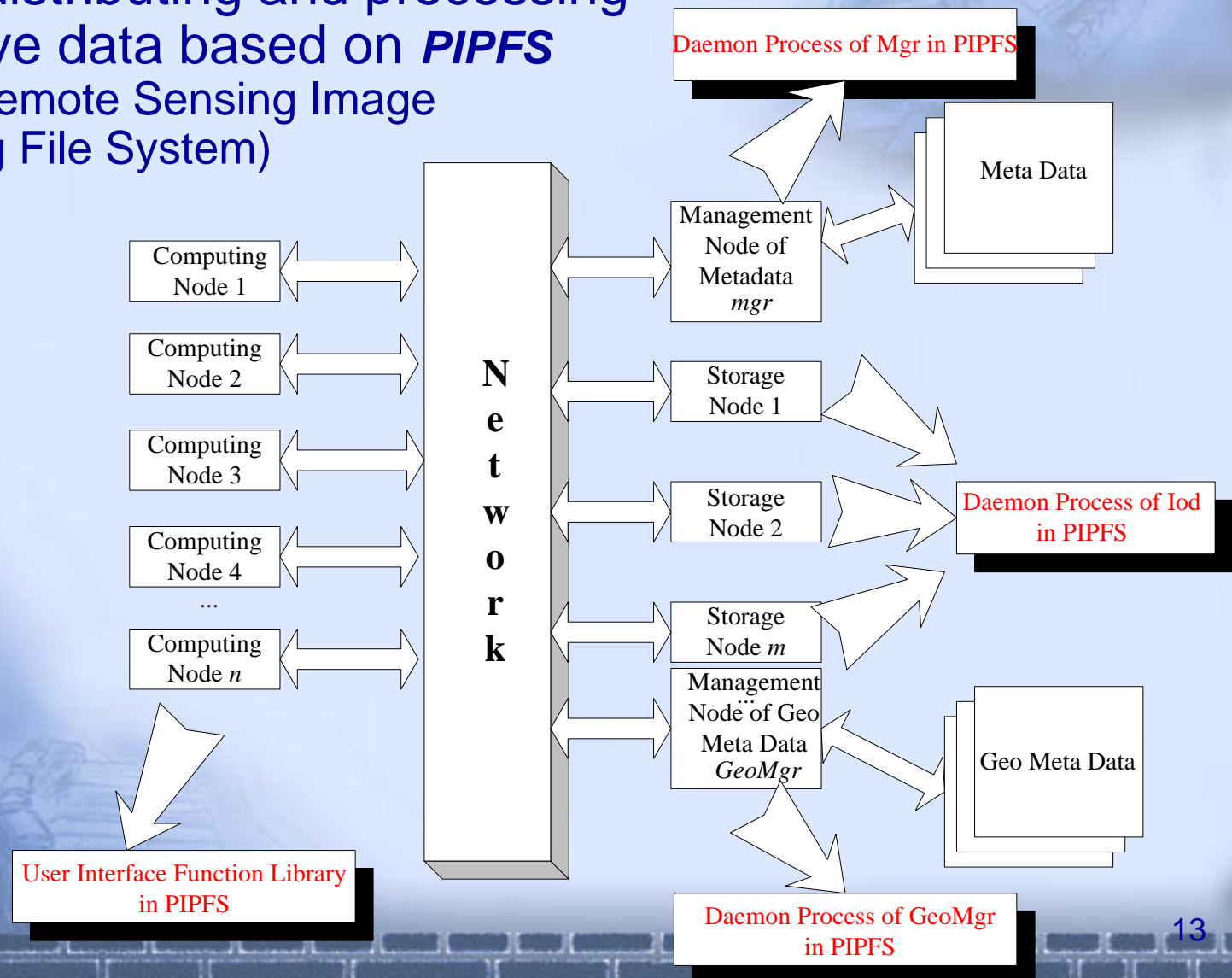
Schedule Strategies (cont.)

➢ Solutions (1)

❖ *Schedule pool*

- Shared by OMS-C and OMS-M and exchange instructions between both

- OMS-M will control and allocate cluster resources for each task based on instructions through system status

Schedule Strategies (cont.)

➢ Solutions (2)

❖ Parallel distributing and processing of massive data based on *PIPFS* (Parallel Remote Sensing Image Processing File System)

Daemon Process of Mgr in PIPFS

Meta Data

Computing Node 1

Computing Node 2

Computing Node 3

Computing Node 4
...

Computing Node *n*

N e t w o r k

Management Node of Metadata *mgr*

Storage Node 1

Storage Node 2

Storage Node *m*
...

Management Node of Geo Meta Data *GeoMgr*

Daemon Process of Iod in PIPFS

Geo Meta Data

User Interface Function Library in PIPFS

Daemon Process of GeoMgr in PIPFS

Schedule Strategies (cont.)

➢ Solutions (3)

❖ *Multi NFS nodes*

▪ Distribute the data efficiently and provide high data throughput
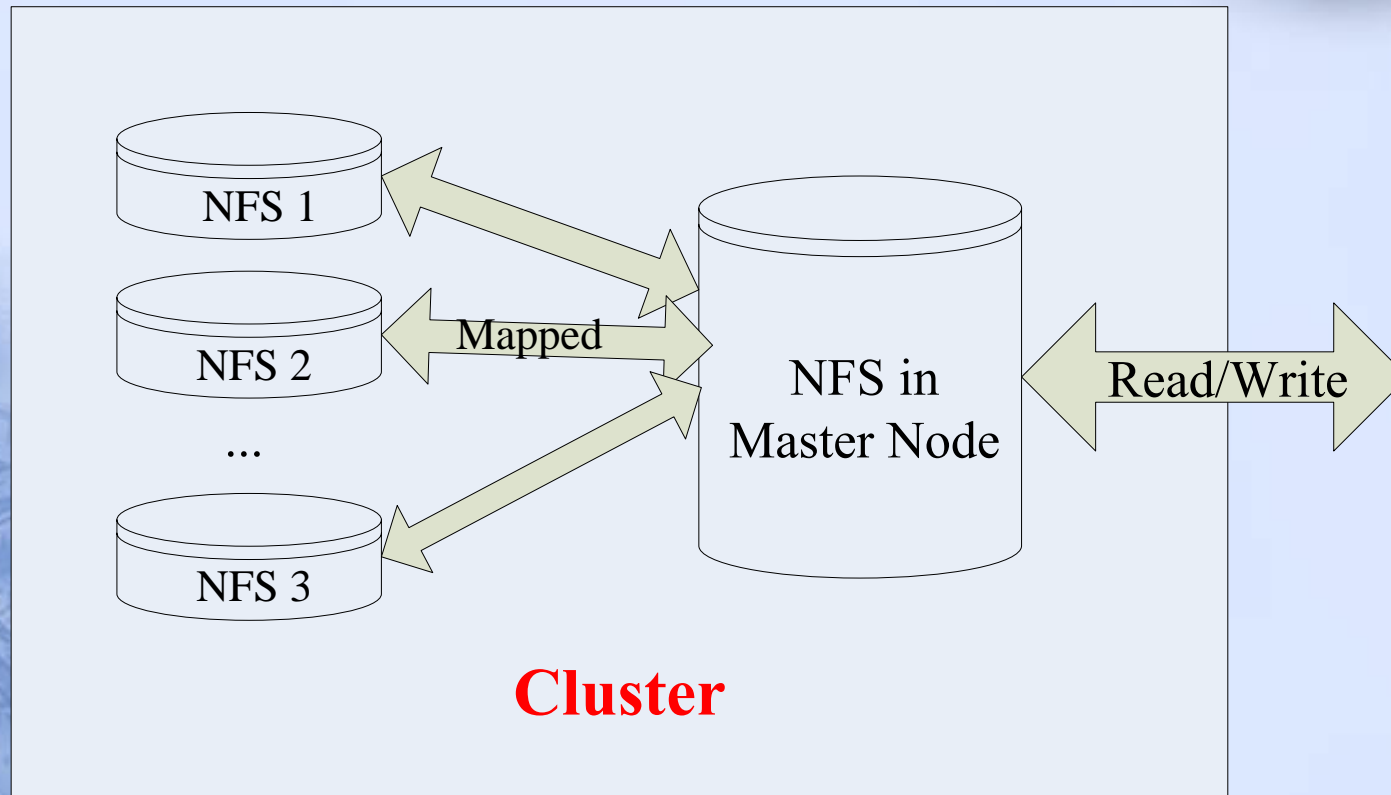
Schedule Strategies (cont.)

➢ Solutions (4)

❖ *Two categories parallel strategies*

- Task-level: none computation-sensitive operations
  - such as GETRAWDATA
- Algorithm-level: computation-sensitive algorithms and massive data processing based on MPI and PIPFS
  - such as RESAMPLE

Results

➢ Can generate over fifteen processing workflows

➢ New processing task will be easily added

➢ Three radiation and geometric calibration modes

➢ Support more than 20 projections

➢ Stably schedule 100 tasks with 30MB/s through-out capability simultaneously

➢ Processing Beijing-1, CBERS-1, etc.

Future Work

➢ Flexible design and runtime control for processing using graphic tools

➢ Standard of Ground Station Processing Markup Language

❖ Based on XML

❖ Consistent with WFMC schema

➢ Other relevant design toolkits

❖ Computational resource organization chart

❖ Processing flow designer studio

❖ Automation parser

Thanks!