Tandem

- Tandem
  - from
- to HP

Tandem

- Background
- Tandem NonStop Systems - Cyclone
  - Commercial Database Systems with very long MTTF
  - Modularity
    - units of service, failure, diagnosis, repair, growth
    - fault containment regions
    - expandable for performance
Tandem

- Fail Fast Mode
  » terminate operation immediately after error detection
  » reduces error propagation
  » single error corrections/ double error detection
  » ECC, data coding
  » hardware self checking
  » software and firmware consistency checks
  » after failure OS distributes processors applications on remaining processors
  » load balancing is transparent to user

Tandem

- Architecture (Overview in Pra96. Fig. 4.1)
  » loosely coupled MIMD, up to 16 processors
  » dual processors, independent & asynchronous
  » heavy use of low-level dual redundancy
  » multiple, physically separate sections
  » each section: up to 4 processors, communication via Dynabus
  » write through cache
  » mirrored disks

- Processor Pair
  » primary/backup approach
  » primary sends checkpoints
  » when primary proc. fails:
    ■ backup becomes primary
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- **Hardware Fault Tolerance**
  - single fault tolerance
  - primary objective to prevent single fault to bring down system
  - redundant hardware: processors, busses, I/O controllers, disks, power supplies
  - spare RAM chips
  - each processor has own power supply

- **Software Fault Tolerance**
  - processors can detect other halted processors
  - “I'm alive" protocol
  - GUARDIAN 90 OS maintains idle backups of user processes
  - Processor consistency check via checkpoint messages

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**Tandem**

- **Networking and I/O**
  - Networks
    - Dynabus: 40 MB/s = 2 independent 20 MB/s buses
    - Dynabus+: 4 unidirectional fiber optics,
      - up to 50m physical separation
      - robust to electro-magnetic interference
  - I/O
    - processor can support 2 I/O systems
    - each system has 2 channels
    - each channel supports up to 32 I/O devices
    - burst data of 5 MB/s = 10 MB/s per processor
    - DMA I/O
    - mirrored disks (dual ported)
Tandem

- On-line Maintenance
  » Field replaceable units (FRU)
    - processors
    - I/O controllers
    - fans
    - power supplies
    - can be installed/replaced by user
  » Warm swaps of FRU
  » Effective MTTR = milliseconds
    => very high Availability

Tandem

- Tandem - Himalaya
  - Main features
    » loosely coupled massively parallel computer
    » 2 to 4080 processors
    » cross-coupled MIPS R4400 RISC processors
      - one logical processor
      - both processors operate in lockstep
    » 32K primary cache, 4MB secondary cache
    » up to 256 MB RAM
    » 4 independent I/O channels
    » fiber-optic TorusNet
      - horizontal controller => 4 sections (each section = 4 processors)
      - vertical controller => 14 nodes = domain
      - depth controller => 16 domains
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- Himalaya 2000

K2000SE server
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- TorusNet
  » section
  » node
  » ring

optional expansion cabinet

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- K200, K2000, K20000 Servers Spec. Features:
  » Target: online transaction processing
  » standard RISC technology
  » loosely coupled architecture
  » dual interprocessor buses
  » dual-ported controllers
  » fault-tolerant power subsystem
  » in case of power outage server memory is preserved via integrated battery backup

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**NonStop Operating system**

- core of Tandem’s open systems environment
- enables operation to run primary and backup processes
- before performing any critical function, sends backup process a checkpoint message containing data and status information
- kernel supports end-to-end integrity features
- micro-kernel is message-based (parallel processing software)
- kernel supports application program and operations control interfaces called “personalities”
- these personalities support applications from different platforms
- e.g. relational database management personalities applications can be developed using:
  - SQL, Data Access Language (Macintosh), SQL Server (Microsoft/Sysbase), ODBC (Microsoft), Oracle Tools (Oracle)
**Tandem**

- other personalities are transaction processing personalities allows parallel transaction processing services for different systems
- “guardian services” allow compatibility to Tandem applications
- “open systems services” supports UNIX

![Diagram](image)

**Tandem**

- Transaction Manager (NonStop TM/MP) deals with effects of incomplete transactions, system failures and network failures.
- Remote Duplicate Facility allows data to be located remote to shield from environmental disaster.
- Safeguard security management facility deals with security issues
- Network support includes TCP/IP, IPX/SPX, NETBIOS, AppleTalk, SNA, OSI and ATM
**Tandem**

- Maintenance
  - key data logged and evaluated by expert-system to identify potential problem
  - can dial automatic to online support center
  - field replaceable units can be exchanged by warm swaps

Most components of Himalaya servers—including processors, I/O controller boards, storage devices, power supplies, and fans—are designed to be installed and serviced by users.

**Himalaya processor specifications**

<table>
<thead>
<tr>
<th>Configurations</th>
<th>K2000</th>
<th>K20000 TandemNet</th>
<th>K20000 TandemNet</th>
<th>K20000 TandemNet</th>
<th>K20000 Multikometah TandemNet</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIPS processor type</td>
<td>MIPS R4400/125 MHz</td>
<td>MIPS R4400/200 MHz</td>
<td>MIPS R4400/125 MHz</td>
<td>MIPS R4400/200 MHz</td>
<td>MIPS R4400/200 MHz</td>
</tr>
<tr>
<td>Maximum processors</td>
<td>4</td>
<td>16</td>
<td>16</td>
<td>224</td>
<td>4,080</td>
</tr>
<tr>
<td>Relative performance range²</td>
<td>2 x</td>
<td>2 x</td>
<td>3.8 x</td>
<td>3.9 x</td>
<td>3.9 x</td>
</tr>
<tr>
<td>Cache (per processor)</td>
<td>1 MB</td>
<td>1 MB</td>
<td>4 MB</td>
<td>4 MB</td>
<td>4 MB</td>
</tr>
<tr>
<td>Maximum main memory²</td>
<td>512 MB</td>
<td>4,096 MB</td>
<td>4,096 MB</td>
<td>57 GB</td>
<td>1,044 GB</td>
</tr>
<tr>
<td>Maximum disk storage²</td>
<td>184 GB</td>
<td>3,232 GB</td>
<td>65 TB</td>
<td>918 TB</td>
<td>16,711 TB</td>
</tr>
<tr>
<td>Maximum I/O channels</td>
<td>4</td>
<td>16</td>
<td>64</td>
<td>886</td>
<td>16,320</td>
</tr>
<tr>
<td>Multiprocessor controllers</td>
<td>2 proc cabinet</td>
<td>2 proc cabinet</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Minimum battery hold-up time</td>
<td>3.75 hr</td>
<td>2 hr</td>
<td>2 hr</td>
<td>2 hr</td>
<td>2 hr</td>
</tr>
</tbody>
</table>
Tandem was bought by Compaq which merged with HP in 2002.

- HP Integrity NonStop server: [www.hp.com/go/nonstop](http://www.hp.com/go/nonstop)
- HP NonStop Advanced Architecture (NSAA)
  
  » Software fault tolerance
  » Hardware fault tolerance
  » Scalability from 2 to 4,080 processors
  » Scalability to 65 TB of main memory
  » Online database and application manageability
  » Query processing while maintaining transaction response times
  » Data integrity
  » Leverage of industry standards in hardware and software

**HP Integrity NonStop servers**

Ultra-robust servers that deliver 24x7 continuous availability, unrivaled data integrity, and virtually unlimited scalability—ideal for demanding, transaction-intensive applications.

**HP Integrity NonStop NS2100 server**

Entry-class, high levels of availability and data integrity for cost-effective commercial server.

**HP Integrity NonStop NS2200 servers**

Excellent price-performance, software fault-tolerant solution for small to mid-size enterprises.

**HP Integrity NonStop BladeSystem NS4400c servers**

Industry-leading 24x7 availability, scalability, and data integrity with a high level of performance.

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**Processors supported**

<table>
<thead>
<tr>
<th></th>
<th>Processor Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP Integrity NonStop</td>
<td>Intel Itanium 9300 series</td>
</tr>
<tr>
<td>Host Node</td>
<td>Intel Itanium 9300 series</td>
</tr>
<tr>
<td>HP Integrity NonStop</td>
<td>Intel Itanium 9300 series</td>
</tr>
</tbody>
</table>

**Clustering**

<table>
<thead>
<tr>
<th></th>
<th>Number of processors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry-Class</td>
<td>2 – 4</td>
</tr>
<tr>
<td>Scalability</td>
<td>2 – 16 per node</td>
</tr>
</tbody>
</table>

**Licensable cores per processor**

<table>
<thead>
<tr>
<th></th>
<th>1 (fixed)</th>
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<tbody>
<tr>
<td>2 (fixed)</td>
<td>2 (fixed)</td>
</tr>
<tr>
<td>2 or 4 (user’s choice)</td>
<td>2 or 4 (user’s choice)</td>
</tr>
</tbody>
</table>

**Maximum number of logical processors per cluster**

<table>
<thead>
<tr>
<th></th>
<th>1024 (expand-over-I#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>1024/expand-over-I#: 4080</td>
</tr>
</tbody>
</table>

**Maximum memory (cluster)**

<table>
<thead>
<tr>
<th></th>
<th>4080 GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>4080 GB</td>
</tr>
</tbody>
</table>

**ServerNet processor connectivity**

<table>
<thead>
<tr>
<th></th>
<th>Verifiable I/O (Verifiable I/O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>Bladefile server switches</td>
</tr>
</tbody>
</table>

**I/O Infrastructure**

<table>
<thead>
<tr>
<th></th>
<th>HP CIU, Storage CLM, Telos CIU</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>HP CIU, Storage CIU, Telos CIU</td>
</tr>
</tbody>
</table>

**Maximum Clustered I/O Modules (CI/ClUP)**

<table>
<thead>
<tr>
<th></th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>48</td>
</tr>
</tbody>
</table>

**Maximum I/O Adapter Module Enclosure (IOMME) adapters**

<table>
<thead>
<tr>
<th></th>
<th>60</th>
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</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>60</td>
</tr>
</tbody>
</table>

**Maximum disk drives**

<table>
<thead>
<tr>
<th></th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>200</td>
</tr>
</tbody>
</table>

**Management**

|                      | DSM, HP SIM, HP Insight Control for NonStop, HP NonStop Essentials, Web ViewPoint, IEM, HP IT Performance Suite |

**Rack Height (EMA unit)**

<table>
<thead>
<tr>
<th></th>
<th>42U</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>42U</td>
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</table>

**Telco options**

<table>
<thead>
<tr>
<th></th>
<th>Linksys and Huawei</th>
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<tbody>
<tr>
<td>HP NonStop DS (L-Series)</td>
<td>Linksys and Huawei</td>
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</tbody>
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The Itanium processor family

The Itanium processor delivers the best performance for enterprise-level workloads today, and Intel is investing heavily in the future of the Itanium processor family; for example, Intel will soon introduce the ability to have multiple microprocessors on the same die, which will significantly improve the performance delivered from the same footprint. A key benefit of moving to the NSAA for HP NonStop system customers, therefore, is that the Integrity NonStop platform is now able to take advantage of Intel's aggressive Itanium product roadmap. This will enable HP to deliver successive improvements in the price/performance of the Integrity NonStop server.

The Intel Itanium processor delivers advanced parallelism, scalability, and reliability for enterprise-level applications and databases. All new Itanium processors deliver lower cost, increased flexibility, and greater choice than proprietary RISC-based solutions. The Itanium processor family brings the advantages of volume economics into the high-end computing environment.

Intel bases its business model on broad collaboration and high-volume manufacturing. Development work on several new processor generations, and Intel continues to deliver on its goal of increasing processor and price performance. The Itanium processor family makes it possible to build high-end computing solutions using powerful, flexible, and affordable industry-standard building blocks. The key point is this: The Itanium processor family is both industry standard and industry leading, and it brings important benefits to the new Integrity NonStop server.

HP Integrity NonStop

XP12000 Disk Array

- **Reliable**: Provides extreme reliability with no single point of failure
- **Available**: All components are redundant and hot-swappable
- **Scalable**: Scalable to 165 TB of internal capacity, 14 PB of external capacity, and 128 GB of cache
- **Performance**: Uses an advanced crossbar fault-tolerant architecture, resulting in outstanding levels of random and sequential I/O operations for database and OLTP workloads
- **Heterogeneous**: Supports multiple operating systems
- **Open Connectivity**: Supports Fibre Channel, FICON, and ESCON connectivity
- **Flexible**: Supports a mixture of disk drives configured as RAID 1 and RAID 5