Intel New Mexico Manufacturing Operations

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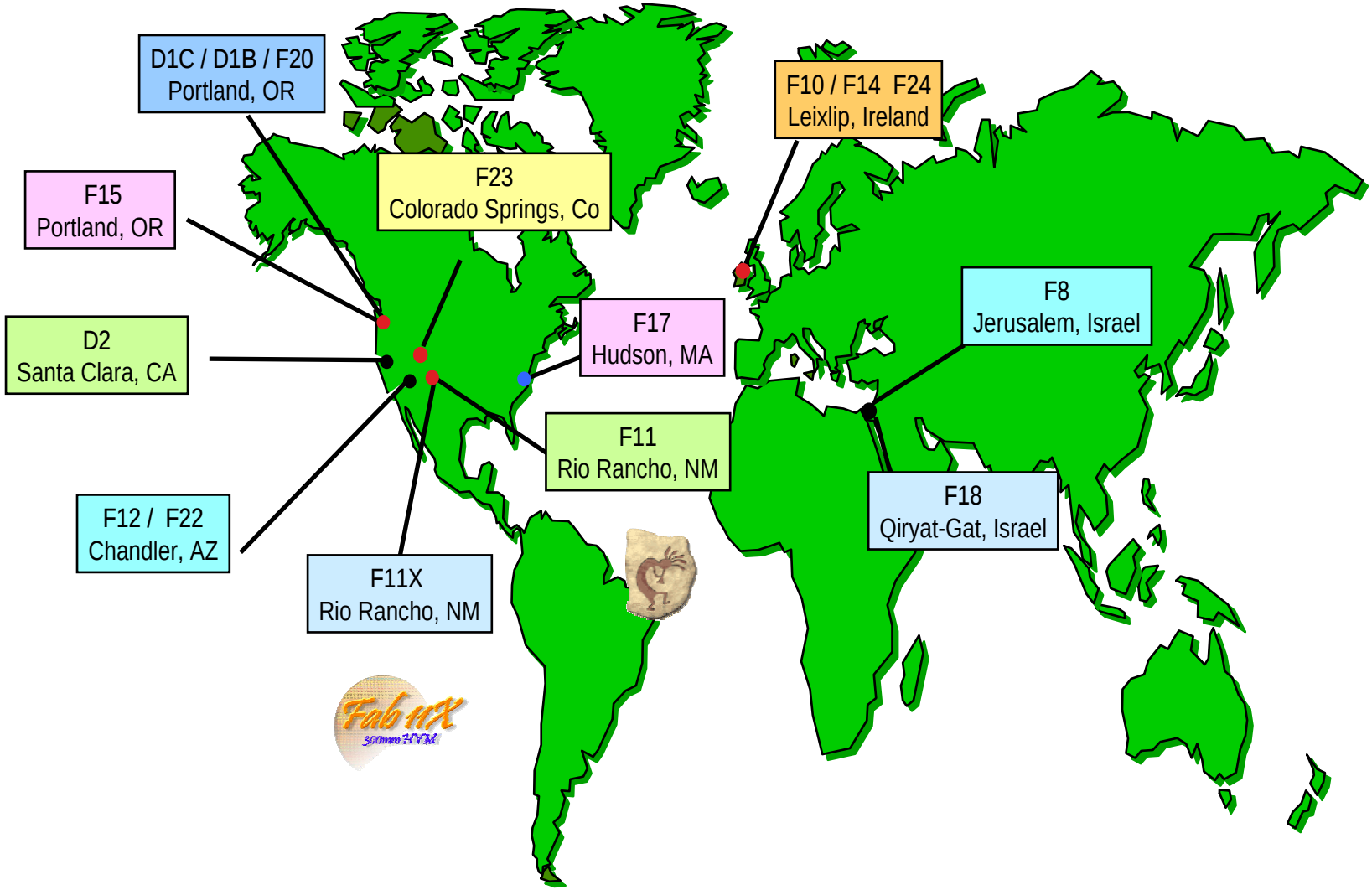
Outline

- Intel's Worldwide Production
- New Mexico Production Facilities
- Production of Chips
- Impacts of Interrupted Operations
  - Warmdowns, Y2K, Power Outage
- Continuous Operations
- Windows into our Operations

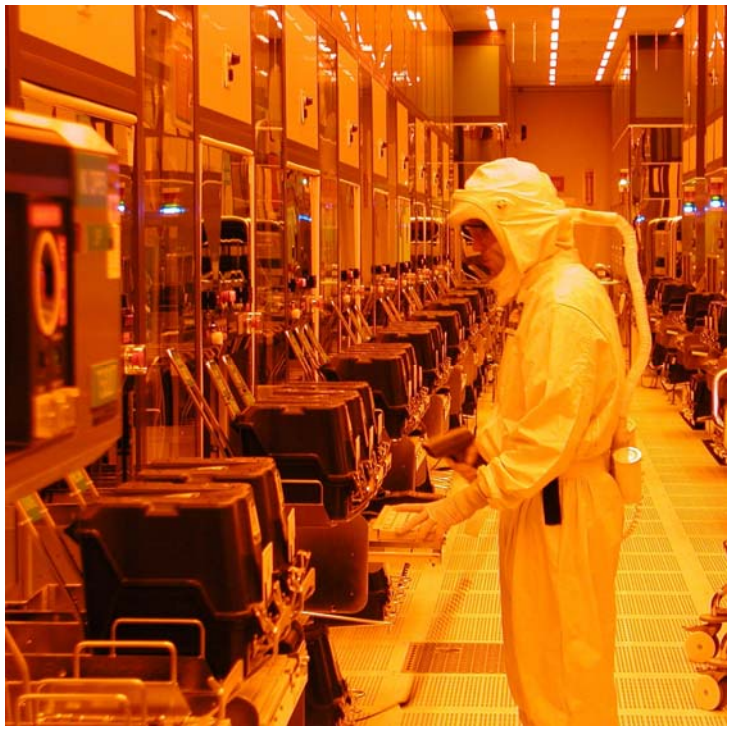
Intel's Global Factory Network



Fab Sort Manufacturing has plants located in the United States, Israel, and Ireland. FSM is responsible for all of Intel's wafer fab manufacturing, including microprocessors, micro controllers, flash memories, chipsets, and other devices.

Worldwide Manufacturing at a Glance…

- Handouts provided



- Intel's largest & most flexible wafer Fab facility
  - 8" Silicon wafers started in 1993
  - 300 K sq. ft (~ 6 football fields)
  - Run multiple technologies
    - Flash Memory
- Makes 5 chips / sec, 24 hrs/day, 364 days/yr
  - 1 Billionth chip produced in Q3/02

- Intel's first High Volume 300mm Manufacturing facility
- Grand opening in October 2002
- Named 2003 "Top Fab of the Year" by Semiconductor International
- Manufactures the fastest, most powerful microprocessors in the world

Production of Chips

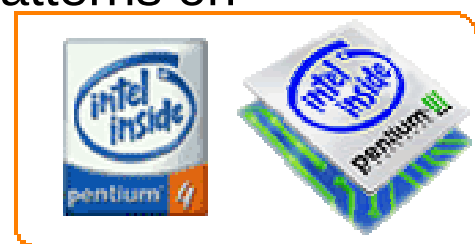
Chip Production

•**Silicon Wafers** cut from an ingot of pure silicon, are used by Intel to make microprocessors. Silicon, the primary ingredient of beach sand, is a semiconductor of electricity. Semiconductors are materials that can be altered to be either a conductor or an insulator.

• **Metals**, such as aluminum and copper, are used to conduct the electricity throughout the microprocessor. Gold is also used to connect the actual chip to its package.

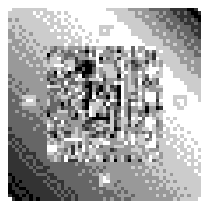
• **Ultraviolet (UV) Light** has very short wavelengths and is just beyond the violet end of the visible spectrum. UV light is used to expose patterns on the layers of the microprocessor in a process much like photography.

• **Masks** used in the chip-making process are like stencils. When used with UV light, masks create the various circuit patterns on each layer of the microprocessor.



Chip Production

- **Fabrication**
  Microprocessors are built in layers on a **silicon wafer** through various processes using chemicals, gases, and light.
- On the wafer, the first layer of **silicon dioxide** is grown by exposing it to extreme heat and gas. This growth is similar to the way rust grows on metal when exposed to water. The silicon dioxide on the wafer, however, grows much faster and is too thin to be seen by the naked eye.
- The wafer is then coated with a substance called **photoresist**. Photoresist becomes soluble when exposed to ultraviolet light.



Chip Production

- **Layering**
  In a process called **photolithography**, **ultraviolet light** is then passed through a patterned **mask**, or stencil, onto the silicon wafer. The mask protects parts of the wafer from the light. The light turns the exposed areas into a gooey layer of photoresist. Each layer on the microprocessor uses a mask with a different pattern.

Chip Production

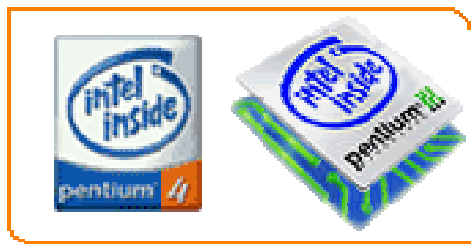
- **Etching**
  The photoresist is completely dissolved by a solvent. This reveals a pattern of photoresist made by the mask on the silicon dioxide. The revealed silicon dioxide is **etched** away with chemicals.
- The rest of the photoresist is removed. This process leaves ridges of silicon dioxide on the silicon wafer base.

Chip Production

- **Ion Implantation**
  Through a process called ion implantation (also called doping), the exposed areas of the silicon wafer are bombarded with various chemical impurities called **ions**. Ions are implanted in the silicon wafer to alter the way silicon in these areas conducts electricity.

Chip Production

- Layers and Layers
  - The layering and masking processes are repeated multiple times throughout the production process.
  - The exact number of layers on a wafer depends on the design of the microprocessor.



“Copy Exactly” Production

- “Copy Exactly” solves the problem of getting production facilities up to speed quickly by duplicating everything from the development plant (Santa Clara and Portland, OR).
- With “Copy Exactly” each fab across the world operates nearly identical. Because of this, wafers can be partially completed in one fab and finished at another.
- By creating a global virtual fab network, Intel limits impact from natural or man-made disasters. The rest of the fab network is able to continue shipping production to customers.

Impacts of Interrupted Operations

Impacts of a Shutdown

- Ceasing operations within the fabs such that chemical delivery to the tools cease will significantly damage and potentially destroy tools
  - Advanced photolithography tools (approximately 400 in Fab 11), each costing between $3 M and $35 M could potentially be irreparably damaged.
  - Planar tools would grow bacteria and would require significant time delays to bring these tools on-line again (peroxide kill).
  - Wet Etch tools would grow bacteria and would require significant time delays to bring these tools on-line again (peroxide kill). Dry Etch tools would require significant amount of time to bring them back on-line with the loss of vacuum
  - Implant tools would require a significant amount of time to tune controls and bring the tools back on-line

How do we know impacts?

- Equipment Manufacturers
- Holiday Warmdowns
- Planning for Y2K
- Sitewide Power Loss on March 20, 2000

Equipment Manufacturers

- Our tools are warrantied by the manufacturers, subject to specific operating environment conditions.
- Intel NM tools are reused by other Intel sites as the tools required to support production of particular products change at our site and others
  - We need to ensure healthy tools upon transfer to another site

Warmdowns

- Warmdown planning requires a significant amount of planning and coordination
  - Many tools are required to have continuous power and chemical delivery
    - Lithography and Diffusion tools are not allowed to go down during Holiday warmdowns
- The site has not been put into a warmdown mode, including the holidays, in over 3 years

Y2K Planning

- Planning for the Y2K impacts to computers and tools in the fab required 18 mths planning
- Priority tools included:
  - Lithography tools (environment)
  - Lithography Metrology tools (support to litho)
  - Planar tools (bacteria)
  - Etch tools (bacteria)
- Fortunately the fab experienced no impacts with Y2K

New Mexico Power Outage

- Background
  - The 500 acres of brush fire broke out in the north west portion of New Mexico, about 8 miles west of Farmington. The majority of PNM's power is generated at San Juan generating station which is located very close to Farmington. Three major 345 kV transmission lines that originate from this generating station feed power to much of New Mexico. These lines tripped off due to smoke from this fire over a period of 197 minutes (3 hours 17 minutes). The line trips led to a major power outage across the state.

Results of Power Outage

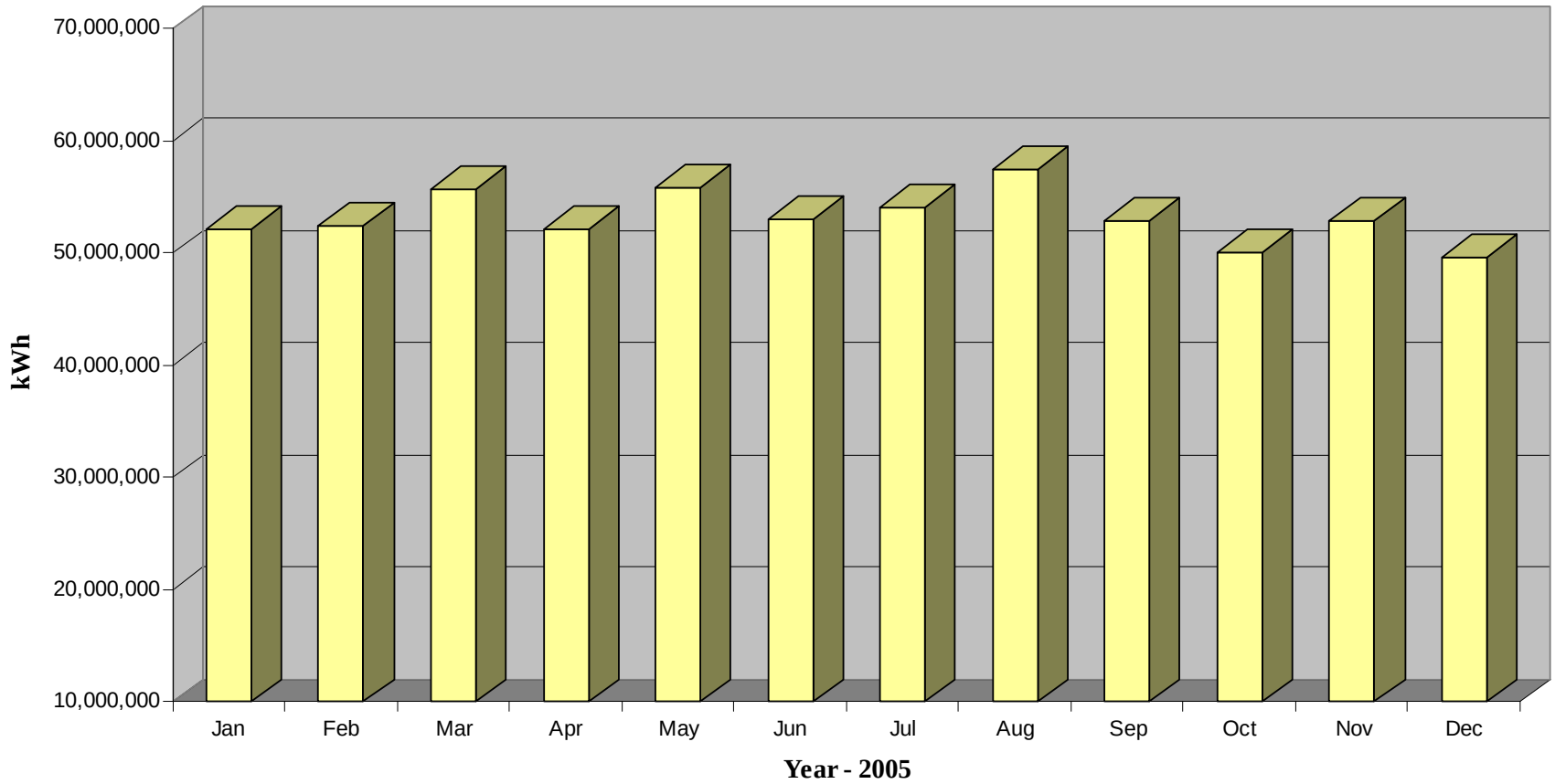
- As a result of the resulting power bump, at 17:18 hours power was lost to the entire site. Power was not restored until 19:15 hours.
- Impact to the site was that we lost nearly half of a week's production (scrapped) and a number of facilities equipment were damaged.
- Highlights:
  - All Life Safety systems worked as designed
  - All UPS and Emergency Generators came on line as designed
  - Utilized Y2K learnings and documentation to understand the impact of failed system
- Lowlights:
  - Did not understand the damage caused by power outage to manufacturing equipment
  - 24 hour delay on parts ordering for manufacturing equipment

Continuous Operations

Electrical Power Usage

- Except for the power outage, Intel New Mexico has never ceased operations nor shut off power to the site

kWh on the New Mexico Site



Windows into Our Operations

- Fab 11 and Fab 11x building layouts provide for visibility into our manufacturing areas
  - Windows
  - Windowed Doors
  - Fab 11X Control Center
- Visitors to the site are welcome to a guided window tour

Access into Our Operations

- Arrangements can be made to access the subfab area for tours of the air handling systems and operations
- Arrangements can also be made for escorted access into the fab