

JSON Structure for IMTS 2016 Machining Simulation

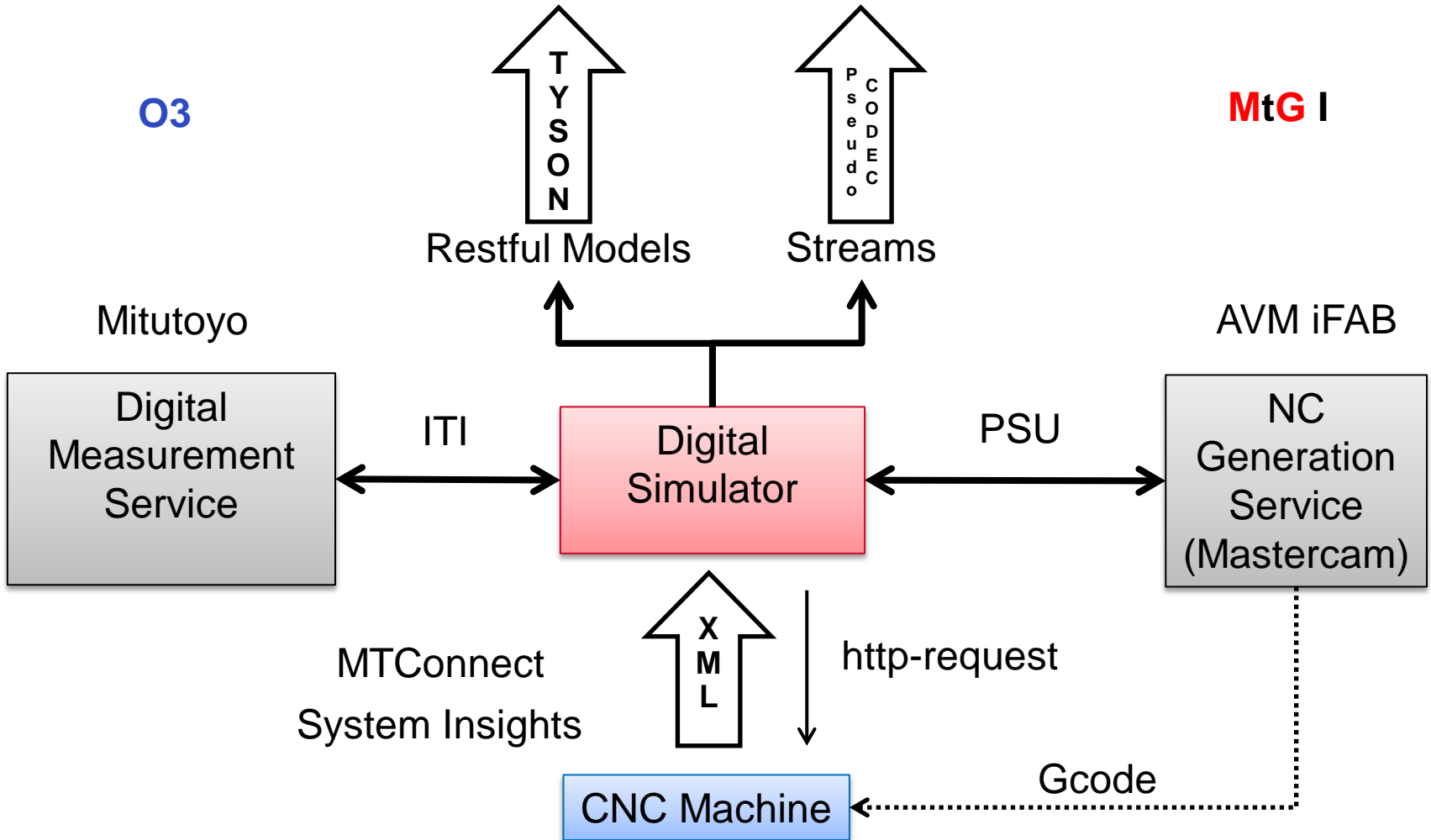
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Smart Phones and Tablets

Vanderbilt GUI

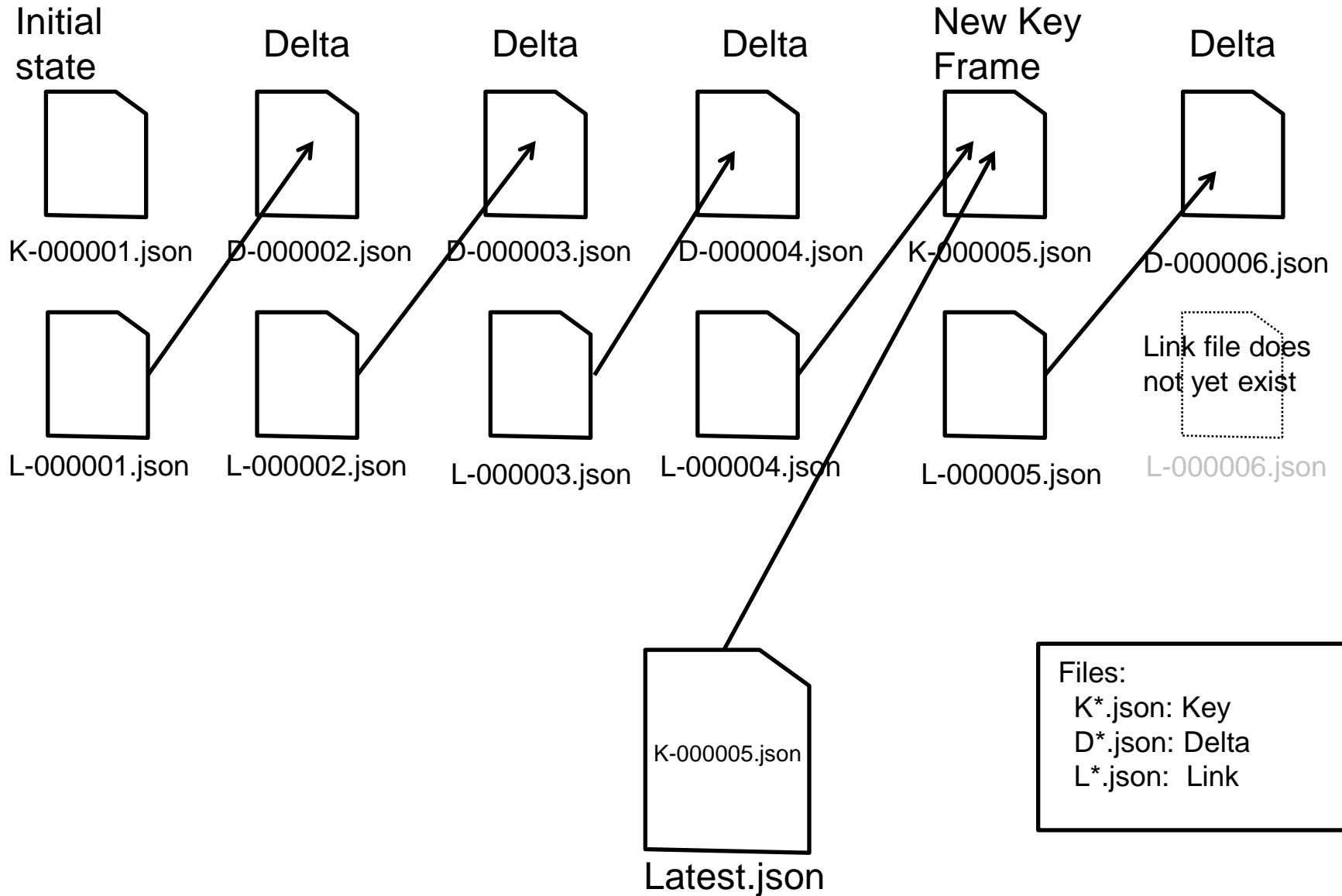
O3

MtG I



- **Simulation frame**
 - A single recorded step of the simulator
 - Generally smaller than a workingstep, or toolpath, but larger than a code.
 - » Where to place the models
 - » What process data to highlight
 - » What volumes to remove (phase 2)
- **Three file types enable the frames**
 - Key file – complete description of a state
 - Delta file – new state described as delta to previous state
 - Link file – pointer to next state file (key or delta)

Simulation Frames Example



State file example

```
{
  project: "a3327686-5673-abcd-aa33-1136cdefaa00",
  workingstep: "ws1"
  time_in_workingstep : 54.21,
  feed: "Rapid"

  geom: [ {
    id : "sh1",
    xform : [2,5,2],
    shell : "23327686-5673-abcd-aa33-ab36cdefaa25",
    usage : "asis",
    visual : "selected"
  },
  {
    id : "sh2",
    xform : [1,0,0, 0,1,0, 5,2,3],
    shell : "23327686-5673-abcd-aa33-ab36cdefaa40",
    usage : "tobe"
  },
  {
    id : "tp_34",
    polyline : "23327686-5673-abcd-aa33-ab36cdefaa42",
    usage : "tool"
  },
  {
    id : "sh3",
    xform : [0,1,0,0, -1,0,0,0, 1,0,0,0, 2,2,0,1],
    state : "23327686-5673-abcd-aa33-ab36cdefaa43"
    usage : machine
  },
] }
```

Program status

Placement for geometry

Placement and orientation

Tool path curve

State file for machine tool

Delta file example

```
{
  project: "a3327686-5673-abcd-aa33-1136cdefaa00",
  workingstep: "ws1",
  time : 55.2,
  feed : "6 ips"
  speed : "500 rpm"
  prev : "K0000012",

  geom: [
    {
      id : "sh1",
      shell : "23327686-5673-abcd-aa33-ab36cdefaa25",
      xform : [2.3,5,2]
    },
    {
      id : "sh2",
      shell : "23327686-5673-abcd-aa33-ab36cdefaa40",
      visual: hide
    },
    {
      id : "sh8",
      shell : "2327686-5673-abcd-aa33-ab36cdefaa48",
      xform : [0,1,0,0, -1,0,0,0, 1,0,0,0, 2,2,0,1],
      usage : "tobe"
      visual: selected
    },
  ]
}
```

Updated program status

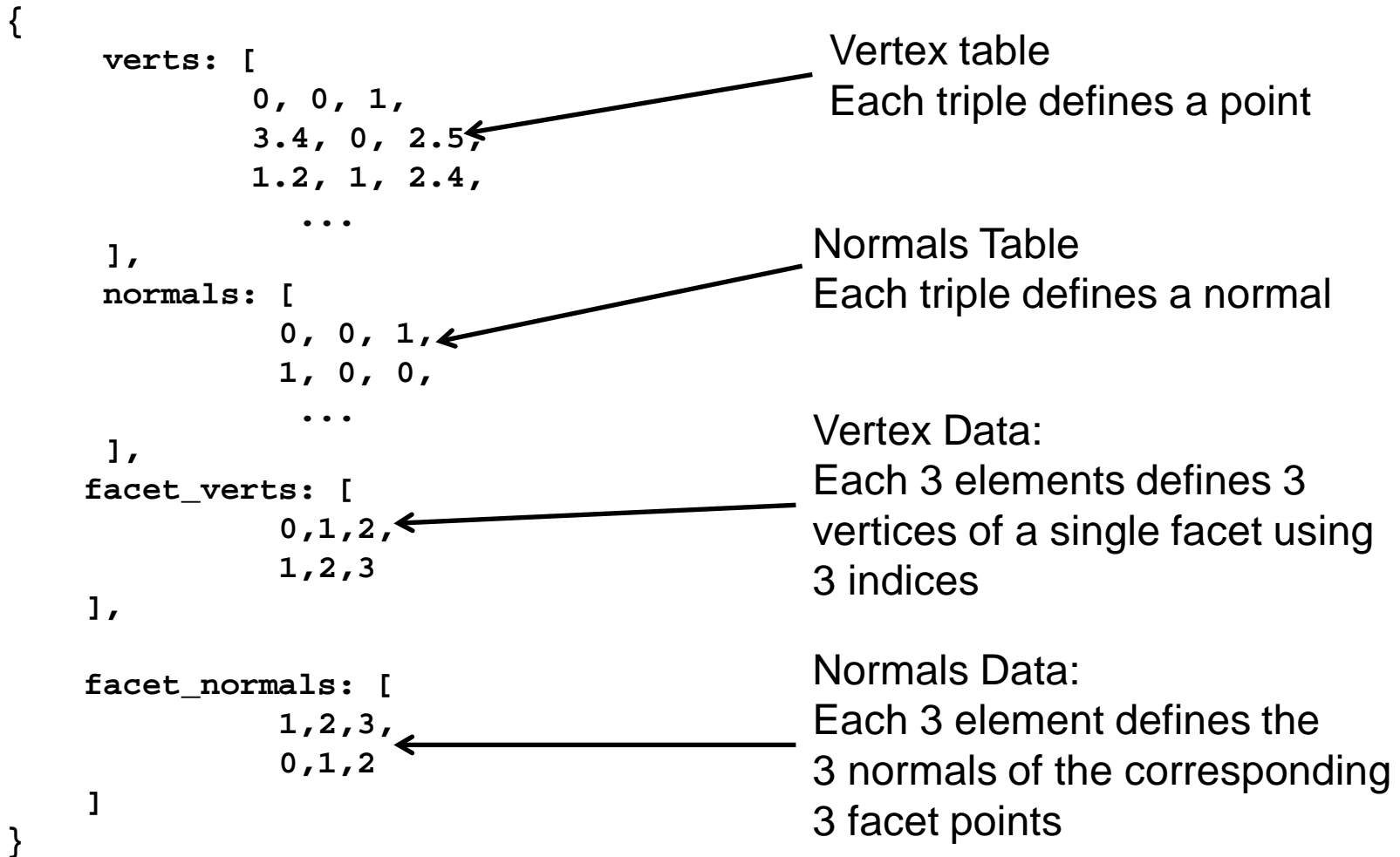
Item moved

Item hidden

Item added (new UUID),
transformed &
highlighted

Workplan File Example

```
{
  workplan: {
    name: "Main Workplan",
    id : "wp_1",
    base_time : 60,
    distance : 567
    children : [
      working_step : {
        id : "ws_2",
        name : "Roughing WS1",
        base_time : 20,
        distance: 430
      },
      working_step : {
        id : "ws_3",
        name : "Finish WS",
        base_time : 40,
        distance: 137
      },
    ]
  }
}
```



Large files encoded as TYSON for efficiency

- **Bootstrap**
 - Initialize the client and synchronize with the server using latest state
- **Follow**
 - Maintain synchronization with the server
- **Garbage Collection**
 - Client side key frame re-initialization
 - Optional when server makes a new key file

- **Goals of this architecture:**
 1. **Service a lot of clients**
 - » **Mirroring and the like can enable even more**
 2. **Allow multiple entries and exits during the show**
 - » **Can synchronize whenever you join the stream**
 3. **Enable lightweight clients that can be enriched later:**
 - » **More autonomy in playing the process – look ahead, look back**
 - » **Privileged clients that control aspects of the machining process – which branch, when measure**
 - » **Coordination of concurrently cooperating systems (CNC \leftrightarrow PLC) – machines and robots**