Solaris 10 smf(5): Service Management Facility

Liane Praza
Solaris Kernel Development
Sun Microsystems

Sun microsystems

smf(5) tour

- Definitions
- Features
- Compatibility and changes
- Components
- Commands
- Restart relationships
- Service relationships
- Troubleshooting and repair
- Service development

Terms and Definitions

Service

A long lived software object with a well-defined state, error boundary, definition of start and stop, and relationship to other services. A service is often critical to operation of system or fulfillment of business objectives.

Service Management

- service delivery
- administrative interaction
- management of service by system

`smf`(5): Service Management Facility

Predictive Self-Healing

Solaris Fault Manager
Solaris Service Manager (smf(5))

Solaris Fault Manager provides detection and diagnosis of errors, leading to isolation or deactivation of faulty components and precise, accurate administrative messaging.

smf(5) makes Solaris services self-healing. Hardware faults which previously caused system restart are now isolated to the effected services. Services are also automatically restarted in the face of hardware and software faults.

Features

- Service is first class object that can be managed and observed
- Legacy mechanisms still work
- Automated restart of services in dependency order:
  - Administrative error
  - Software bug
  - Uncorrectable hardware error
- Parallel startup

Features

- Easy access to information about misconfigured/misbehaving services
- Admins can get a meaningful *system* view
- Supported enable/disable; changes persist across upgrades and patches
- Securely delegate tasks to non-root users
- Snapshots and repository backup taken automatically: restore, undo

Features

- Unify service delivery
- Enable service-based resource management
- Simplify debugging of boot process; console access provided more reliably
- Boot messages under control of administrator

Compatibility

- Existing SysV init scripts (`/etc/rc?.d`) will just work unless they
  - rely on being run before a Solaris-provided script or effect Solaris-provided infrastructure services
  - require input from console during boot (strongly discouraged)
- Legacy services visible in smf
- Documented `/etc/init.d` scripts work
- Customer or ISV additions to `/etc/inittab` continue to work
- No public configuration files absorbed except...

Changes: inetd.conf

- `inetd.conf` is no longer primary configuration source
- Most Solaris-delivered `inetd`(1M) services have been converted to `smf`(5)
- Remaining entries auto-converted during upgrade by `inetconv`(1M)
- Admin must run `inetconv`(1M) manually after creating entries or adding packages which do so
- Warning messages during boot if unconverted entries exist

Changes: boot

- boot is quieter by default

```
SunOS Release 5.10 Version Generic 64-bit
Copyright 1983-2005 Sun Microsystems, Inc.  All rights reserved.
Use is subject to license terms.
Hostname: demobox
NIS domain name is testlab.example.com
checking ufs filesystems
/dev/rdsk/c1t0d0s7: is logging.
demobox console login:
```

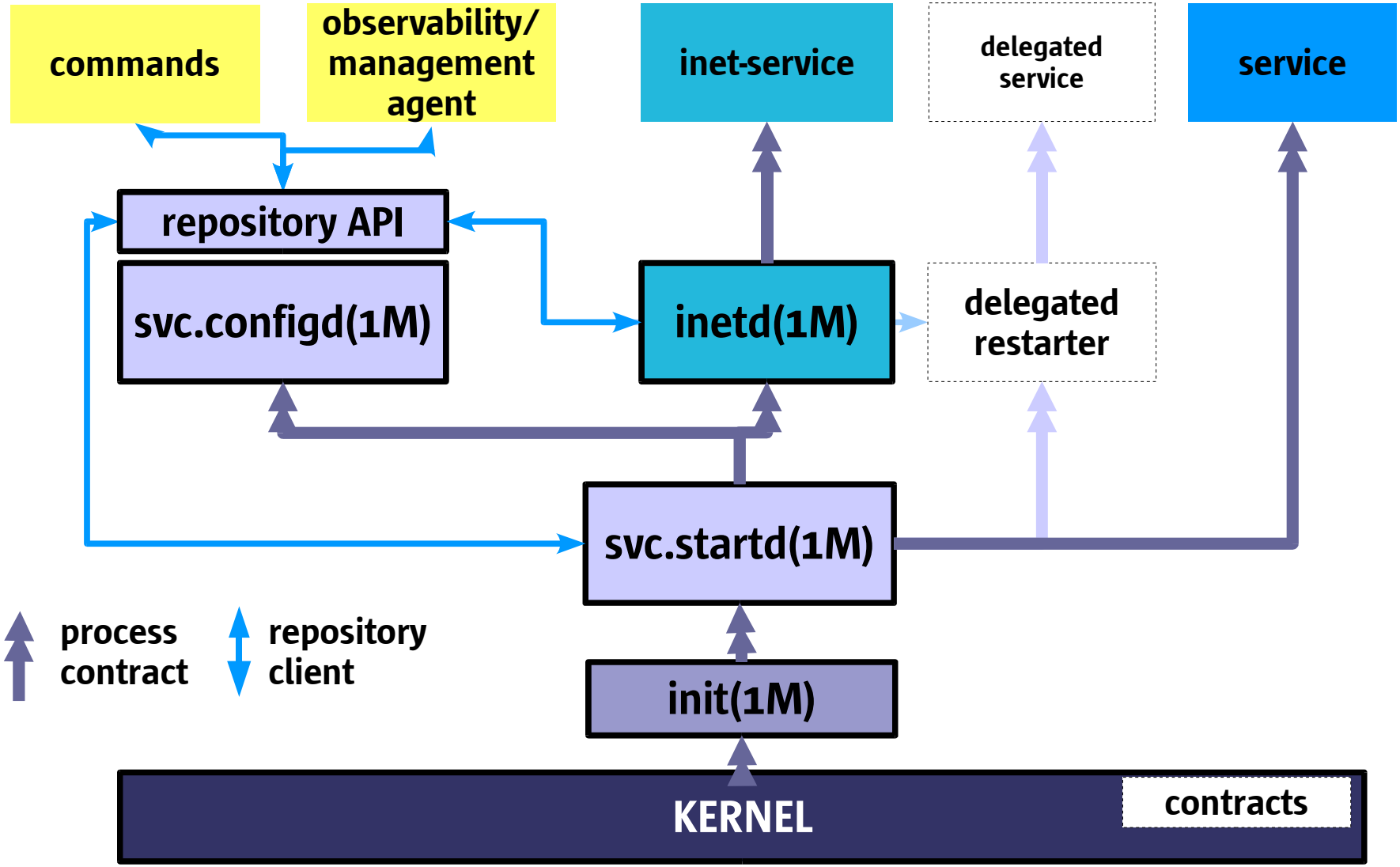
- messages logged to files
- verbose boot available (`boot -m verbose`)

```
SunOS Release 5.10 Version Generic 64-bit
Copyright 1983-2005 Sun Microsystems, Inc.  All rights reserved.
Use is subject to license terms.
[ network/loopback:default starting (loopback network interface) ]
[ system/filesystem/root:default starting (root file system mount) ]
[ network/pfil:default starting (packet filter) ]
[ network/physical:default starting (physical network interfaces) ]
...
```

Changes

- Processes refuse to die
  - Service processes restarted automatically
  - Use `svcadm`(1M) to keep a service from being restarted
- `/etc/init.d` and `/etc/rc*.d` directories, as well as the `/etc/inittab` file, are quite a bit emptier than in previous releases of Solaris

Components: Architecture schematic



Components: Service

- Consistent specification of a software object on a Solaris system
- Stored in the `smf`(5) repository
- Properties divided into property groups
- Includes
  - name
  - localized descriptions and doc references
  - dependencies
  - method specifications (start, stop, etc.)
  - restarter
  - service-specific startup properties

Components: Service Instance

- Running view of a service
- Inherits configuration from service unless explicitly overridden
- One service may have many instances (e.g. Web server on multiple ports)
- Has a well-defined state [*uninitialized, offline, online, degraded, disabled*, or *maintenance*] and a well-defined error boundary [process contract]
- Includes non-persistent property groups
- Named by an FMRI

Components: FMRI

Fault-Managed Resource Identifier

- Category and service

```
svc:/network/smtp:sendmail
```

- Property group and property

```
svc:/network/smtp:sendmail/:properties/general
  /enabled
```

- Commands take abbreviations: 'svc:/' inserted automatically, 'globbed' on instance or service name
- Shell globbing also supported in commands; remember to escape meta-characters if your shell requires it

Components: Service Manifest

- XML description of a service, or set of services
- Delivery mechanism for service descriptions
- Located in `/var/svc/manifest`
- Automatically imported into repository on install, upgrade, boot (by `svc:/system/manifest-import`), and `pkgadd`(1M)
- Ignored once imported
- Sun-delivered manifests NOT for modification
  Customizations should occur in repository, or as a distinct service/instance.

utmpd(1M) service description

```
<service name='system/utmp' type='service' version='1'>
    <create_default_instance enabled='true' />
    <single_instance />
        <dependency name='milestone' grouping='require_all'
            restart_on='none' type='service'>
            <service_fmri value='svc:/milestone/sysconfig'/>
        </dependency>
        <dependent name='utmpd_multi-user' grouping='optional_all'
            restart_on='none'>
            <service_fmri value='svc:/milestone/multi-user'/>
        </dependent>
        <exec_method type='method' name='start'
            exec='/lib/svc/method/svc-utmpd' timeout='60' />
        <exec_method type='method' name='stop'
            exec=':kill' timeout='60' />
    <stability value='Unstable' />
    <template>
        <common_name><loctext xml:lang='C'>
            utmpx monitoring
        </loctext></common_name>

        <documentation>
        <manpage title='utmpd' section='1M'
            manpath='/usr/share/man' />
        </documentation>
    </template>
</service>
```

Components: Service Profile

- An XML file containing listing of service instances and settings for “enabled”
- Located in `/var/svc/profile`
- `/var/svc/profile/site.xml` available for administrators to make local customizations; it is always applied after Solaris-provided profiles
- see `smf_bootstrap(5)` for more detail

Components: Legacy Services

- Started and stopped due to presence in appropriate `/etc/rc?.d` directory
- Faults not handled by `smf`(5); no automated restart
  - software error results in process death
  - administrative error undetected
  - hardware error results in process death
- Script names visible in `svcs`(1) (prefixed by `lrc:`)
- Start time during boot displayed, but not updated if administrator stops or restarts the service

Components: Security

- Enhance security by providing uniform mechanism to disable services
- Provide alternate profiles: `generic_limited_net.xml`
- Specify administrative authorizations to manage and configure services via RBAC (`smf_security`(5)):
  - `solaris.smf.modify`: change all service properties
  - `solaris.smf.manage`: request restart, refresh, etc.
- Define a `method_context` to allow services to easily run as non-root users and with restricted privileges

Components: Repository

- All data (services, methods, etc.) stored in persistent, transaction-based repository
  - Transactions/snapshots allow “undo”, rollback to safe configuration
  - Repository can be local, in directory [later], or mixed [later]
- **NOT** a giant registry: mainly svc mgmt properties
- Can contain simple configurations (a few properties)
  - All configurations in repository can be read/written using a common API ⇒ lowers management s/w development times

See also http://blogs.sun.com/roller/page/lianep/20050208

Components: svc.configd(1M)

- Single access point to repository
- Manages
  - back-end database
  - access control
  - snapshots
  - backups

Components: contract(4)

- Generic mechanism to express relationship between a process and the kernel-managed resources it depends upon
- Process contract: process can create a fault boundary around a set of subprocesses and observe events within the boundary
- Visible via `/system/contract` filesystem

Components: svc.startd(1M)

- Graph engine
  - records service state changes and manages all service restart relationships
  - signals individual restarters on dependency events and administrative requests
  - responsible for run-level management
- Master restarter
  - writes contracts and responds to contract events
  - manages service environment and bindings
  - executes service methods based on graph engine requests

Components: Delegated Restarter

- Assumes responsibility for executing a set of services
- Manages service faults per its own model; may gracefully handle conditions such as process coredumps
- May implement non-process-based service models, e.g. Java
- May define/require additional service configuration
- Often provides functionality common to a specific set of services. e.g. `inetd`(1M).

Components: inetd(1M)

- A delegated restarter for inet services
- Manages inet-specific properties
  - tcp_wrappers
  - max connection rate
- Listens for connections, etc.
- Manages instance state for inet services

Components: init(1M)

- Remains the primordial user process
- Continues its process-reaping duties
- Delegates run-level maintenance to `svc.startd`(1M)
- Restarted by the kernel
- Restarts `svc.startd`(1M)

Commands

- General commands:
  - `svcs`(1) service status listings
  - `svcadm`(1M) administrative actions
  - `svccfg`(1M) general property manipulation
  - `svcprop`(1) property reporting (scripting)
- `inetd`(1M) management commands:
  - `inetadm`(1M) administrative actions/property mods
  - `inetconv`(1M) conversion of legacy inetd.conf entries

Commands

- Contracts subsystem:
  - `ctrun`(1M) execute with process contract
  - `ctstat`(1M) display active contracts
  - `ctwatch`(1M) monitor contract events
  - `libcontract`(3LIB) Contract APIs
  - `/system/contract` contract filesystem

Commands: svcs(1)

- List enabled or all (-a) instances, sorted by state, time
- Explanations for errors/states (-x)
- Show dependencies (-d) and dependents (-D)
- Show member processes (-p), additional details (-v/-l)

```
$ svcs
STATE          STIME    FMRI
....
online         18:18:30 svc:/network/http:apache2
online         18:18:29 svc:/network/smtp:sendmail
....
$ svcs -p sendmail
STATE          STIME    FMRI
online         18:18:29 svc:/network/smtp:sendmail
               18:18:29   100180 sendmail
               18:18:29   100181 sendmail

$ svcs -d sendmail
STATE          STIME    FMRI
online         18:17:44 svc:/system/identity:domain
online         18:17:52 svc:/network/service:default
....
```

Commands: svcadm(1M)

- Enable, disable, refresh, restart service instances
- Mark in special states (maintenance)
- Synchronously wait for changes (-s)

```
$ grep lianep /etc/user_attr
lianep::::auths=solaris.smf.modify,solaris.smf.manage
$ svcs apache2
STATE          STIME    FMRI
-              ?        svc:/network/http:apache2
$ # create /etc/apache2/httpd.conf
$ svcadm enable apache2
STATE          STIME    FMRI
online         19:19:01 svc:/network/http:apache2
$ # edit /etc/apache2/httpd.conf
$ svcadm refresh apache2
$ svcs apache2
STATE          STIME    FMRI
online         19:19:33 svc:/network/http:apache2
$ svcadm disable apache2
$ svcs apache2
STATE          STIME    FMRI
disabled       19:20:07 svc:/network/http:apache2
```

See also http://blogs.sun.com/roller/page/sch/20040923

Commands: `svcadm`(1M) actions

- **enable**: allow start once dependencies are satisfied
- **disable**: stop service and do not allow it to start again
  - **-t**: enable/disable until the system is rebooted
  - **-s**: enable/disable synchronously (wait for it...)
- **refresh**: reload service configuration and run the refresh method (if any)
- **restart**: stop the service, then allow it to start once its dependencies are satisfied (no configuration change made)
- **clear:** mark service as repaired

Commands: `svcadm`(1M) milestone

- Milestone: A service which specifies a collection of dependencies which declare a specific state of system-readiness
- Major milestones, which are analogous to system run-levels can be reached directly from boot (`-m milestone=`), the standard `init` invocations, or via `svcadm: milestone/single-user, milestone/multi-user, milestone/multi-user-server`
- Transitions to milestones are implemented by temporary disable. `svcs`(1M) will show all enabled services that are not part of the milestone as temporarily disabled

See also http://blogs.sun.com/roller/page/lianep/20050204

Commands: svccfg(1M)

- Import, export manifests; apply, extract profiles
- Interactive mode for modifying properties

```
$ grep lianep /etc/user_attr
lianep::::auths=solaris.smf.modify,solaris.smf.manage
$ svccfg -v import /var/svc/manifest/network/http-apache2.xml
svccfg: Refreshed network/http:/apache2
svccfg: Successful import.
$ svccfg
svc:> select network/http:apache2
svc:/network/http:apache2> listprop
...
general                  framework
general/enabled          boolean  false
...
start                    method
start/exec               astring  "/lib/svc/method/http-apache2 start"
start/timeout_seconds    count    60
start/type               astring  method
svc:/network/http:apache> editprop
[$EDITOR launches, allows direct editing of properties]
svc:/network/http:apache2> exit

$ svcadm refresh apache2      # read changed config
$ svcadm restart apache2      # restart with changed config
```

Commands: svcprop(1)

- List properties of services and instances
- Fetch in convenient forms for scripting
- View running or current props (-c), uncomposed (-C)

```
$ svcprop network/http:apache2
...
physical/entities fmri svc:/network/physical:default
physical/grouping astring optional_all
physical/restart_on astring error
physical/type astring service
start/exec astring /lib/svc/method/http-apache2\ start
start/timeout_seconds count 60
start/type astring method
stop/exec astring /lib/svc/method/http-apache2\ stop
stop/timeout_seconds count 60
stop/type astring method
restarter/auxiliary_state astring none
restarter/next_state astring none
restarter/state astring disabled
restarter/state_timestamp time 1102030556.737590000

$ svcprop -p enabled network/http:apache2
false
```

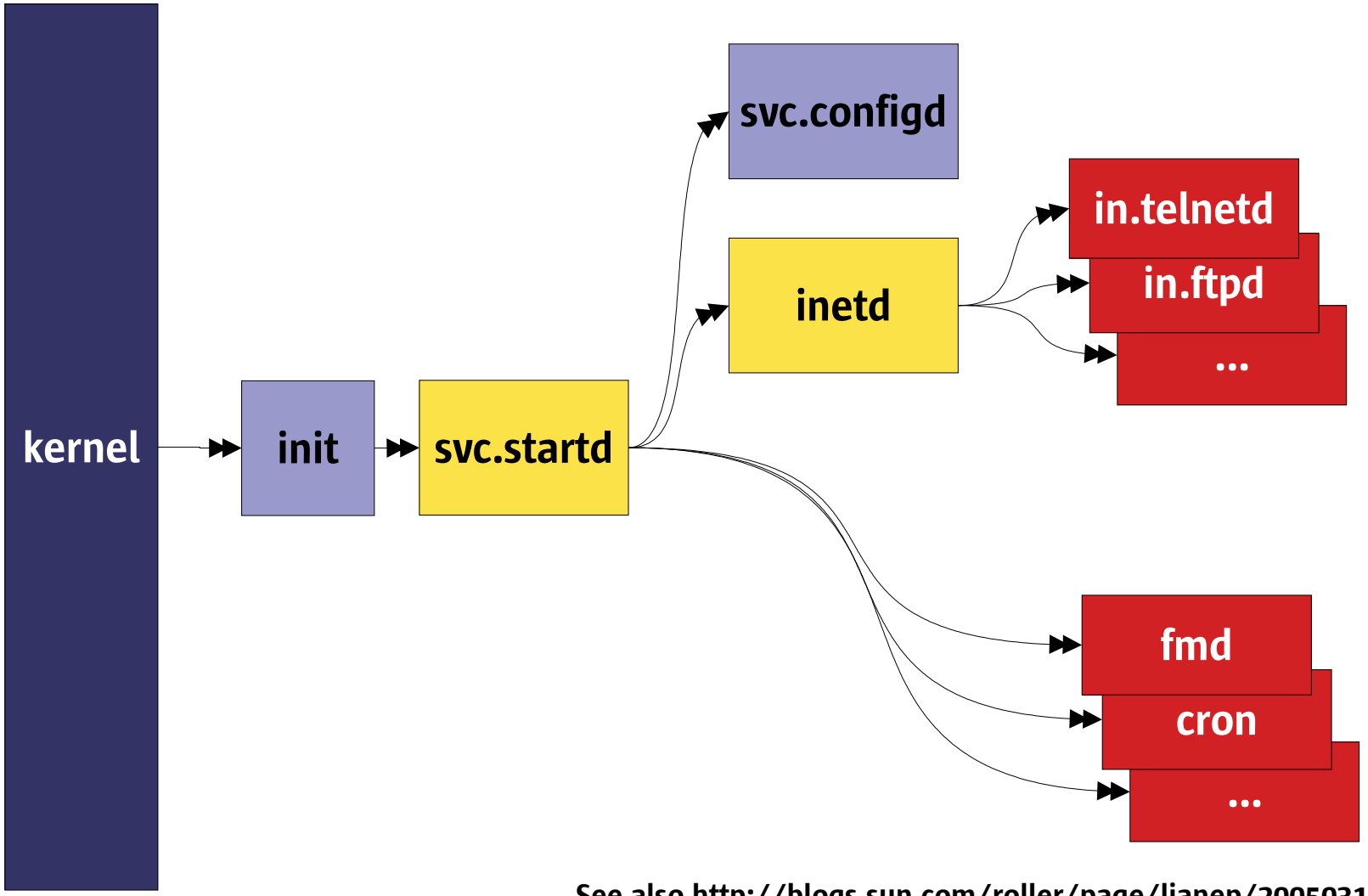
Commands: `inetadm`(1M)

- List services managed by inetd
- View (-l) and modify (-m) inetd-specific properties

```
$ inetadm
...
enabled   online         svc:/network/ftp:default
enabled   online         svc:/network/finger:default
disabled  disabled       svc:/network/login:eklogin
disabled  disabled       svc:/network/login:klogin
enabled   online         svc:/network/login:rlogin
disabled  disabled       svc:/network/rexec:default
enabled   online         svc:/network/shell:default

$ inetadm -l ftp
SCOPE    NAME=VALUE
         name="ftp"
         endpoint_type="stream"
         proto="tcp6"
         isrpc=FALSE
         wait=FALSE
         exec="/usr/sbin/in.ftpd -a"
         user="root"
...
default  tcp_wrappers=FALSE
```

Restart relationships



See also http://blogs.sun.com/roller/page/lianep/20050316

Service relationships

- Restart relationships defined by dependency groups
  - grouping
    - require_all: all services are running
    - require_any: at least one service running
    - optional_all: all services running, disabled, or maint
    - exclude_all: all services disabled, maint, or absent
  - restart_on
    - none: required only for startup
    - error: stop if dependency fails due to h/w or s/w error
    - restart: stop if dependency restarts for any reason
    - refresh: stop if dependency restarts or is refreshed

Troubleshooting

- Service failures printed to console, syslog
- Always start with `svcs -x`; http://sun.com/msg
- `svcs -x` will display the service logfile, if it exists:
  - `/var/svc/log`
  - `/etc/svc/volatile`
- See service start messages with `boot -m verbose`
- For a system that hangs during boot:
  - `boot -m milestone=none`
  - log in at prompt
  - `svcadm milestone all`
  - Watch system progress with `svcs`

Recovery

- If a single service is broken, make sure you've got the latest service config; `svcadm refresh <fmri>`
- Follow instructions from `svcs -x` pointer
- Revert to a previous snapshot.

```
$ svccfg -s system/cron:default
svc:/system/cron:default> listsnap
initial
last-import
previous
running
start
svc:/system/cron:default> revert start
svc:/system/cron:default> exit
$ svcadm refresh cron
$ svcadm restart cron
```

- Read `/lib/svc/share/README`
- Restore repository from backup: http://sun.com/msg/SMF-8000-MY

Service Development

- Conversion may be done piecemeal and is a lightweight act
- Work needed for existing Solaris software is usually:
  - Create a service manifest
  - Make minimal modifications to `/etc/rc?.d` scripts and re-invoke them as service methods

Development: Benefits

- Services appear with `smf`(5) FMRIs
  - Visible using standard Solaris tools; your service appears in administrative heads-up displays
  - Manageable using standard Solaris tools; admin can leverage existing knowledge to use your service
  - New generic tools developed will automatically see your service
- Built-in restart due to administrative error, software, or hardware fault
- Participation in future software diagnosis capabilities

Development: Levels of integration

- Common:
  - Trivial: create simple service manifest, convert init scripts to service methods, minimal testing
  - Full restartability: split monolithic services, each separately restartable component becomes its own service
- Advanced:
  - Customized error/restart handling: avoid service restart if fault can be internally handled

Development: utmpd(1M) example

```
<service name='system/utmp' type='service' version='1'>
    <create_default_instance enabled='true' />
    <single_instance />”
        <dependency name='milestone' grouping='require_all'
            restart_on='none' type='service'>
            <service_fmri value='svc:/milestone/sysconfig'/>
        </dependency>
        <dependent name='utmpd_multi-user' grouping='optional_all'
            restart_on='none'>
            <service_fmri value='svc:/milestone/multi-user'/>
        </dependent>

        <exec_method type='method' name='start'
            exec='/lib/svc/method/svc-utmpd' timeout='60' />
        <exec_method type='method' name='stop'
            exec=':kill' timeout='60' />
    <stability value='Unstable' />
    <template>
        <common_name><loctext xml:lang='C'>
            utmpx monitoring
        </loctext></common_name>

        <documentation>
        <manpage title='utmpd' section='1M'
            manpath='/usr/share/man' />
        </documentation>
    </template>
</service>
```

Development: Other examples

- DTD is self-documenting; read it at
  `/usr/share/lib/xml/dtd/service_bundle.dtd.1`
- Explore `/var/svc/manifest` for similar services
  - `system/utmp` is a simple standalone daemon
  - `system/coreadm` is a simple configuration service
  - `network/telnet` is an inet-managed daemon
- Initial inet service manifests can be created easily by invoking: `inetconv -i <file>`

Additional Resources

- Additional quickstart and developer documentation available at http://www.sun.com/bigadmin/content/selfheal/
- Solaris System Administration Guide has smf information: http://docs.sun.com/app/docs/doc/817-1985
- smf(5) manpage introduces the facility
- Blogs:
  - http://blogs.sun.com/sch
  - http://blogs.sun.com/lianep

liane.praza@sun.com
http://blogs.sun.com/lianep

Sun microsystems