CU CS 4995-03: Internet Systems Programming

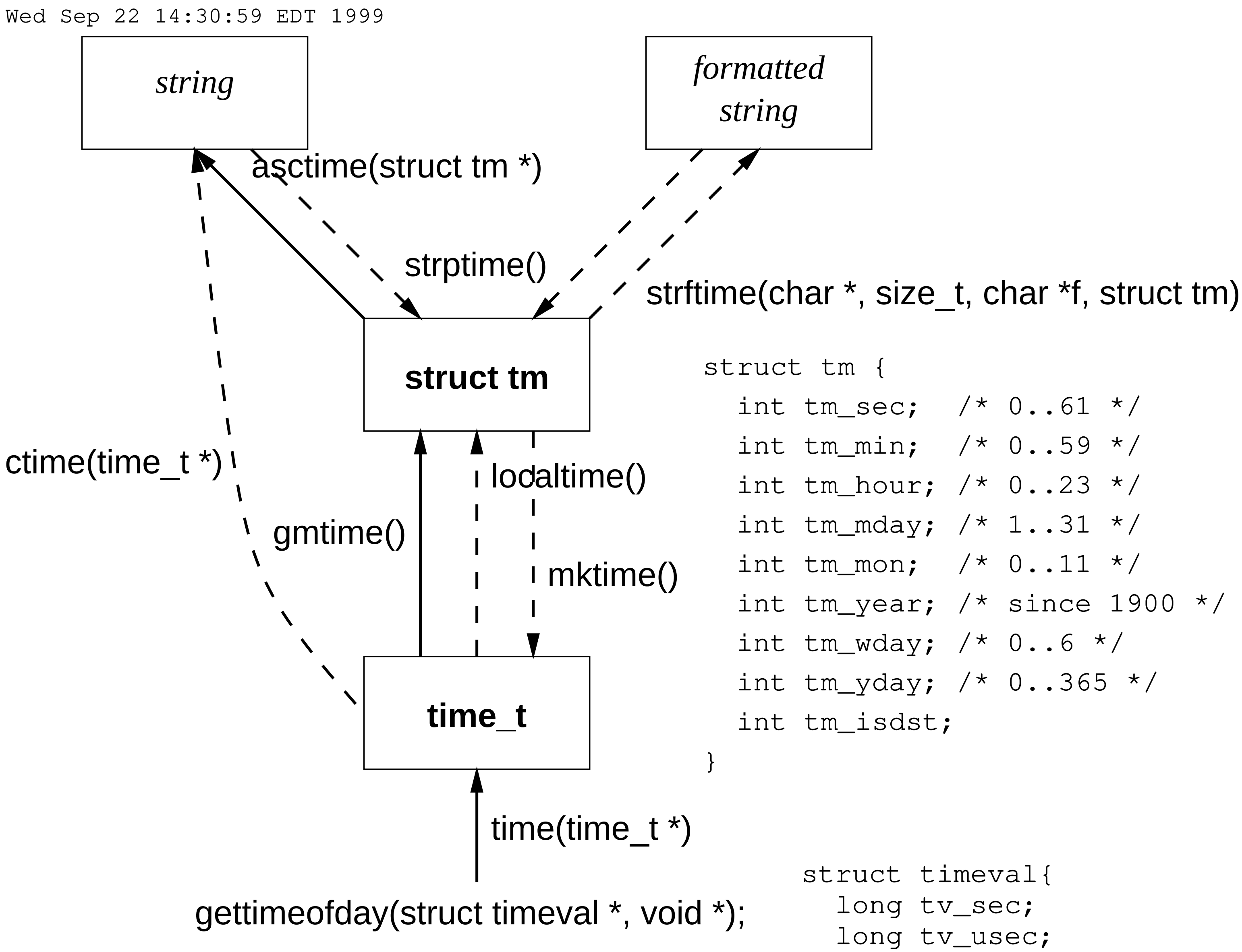
Unix System Calls and Libraries for Time and Date

Overview

- time formats
- clock synchronization

Unix Time Formats

- seconds since GMT, since January 1, 1970
- 32-bit signed `time_t` $\longrightarrow$ 2038 problem
- conversion to 64-bit
- leap seconds




```
struct tm {
  int tm_sec;   /* 0..61 */
  int tm_min;   /* 0..59 */
  int tm_hour;  /* 0..23 */
  int tm_mday;  /* 1..31 */
  int tm_mon;   /* 0..11 */
  int tm_year;  /* since 1900 */
  int tm_wday;  /* 0..6 */
  int tm_yday;  /* 0..365 */
  int tm_isdst;
}
```

```
struct timeval{
  long tv_sec;
  long tv_usec;
}
```

Execution Time

```
clock_t clock(void);
clock_t times(struct tms *buffer);
struct tms {
  clock_t tms_utime;  /* user time */
  clock_t tms_stime;  /* system time */
  clock_t tms_cutime; /* with children */
  clock_t tms_cstime;
}
```

execution time (μs) since process creation

High-Resolution Time

- no wrap-around
- monotonic
- constant rate
- *not* unique (across calls)

Real and execution time:

```
typedef longlong_t  hrtime_t;
hrtime_t gethrtime(void);
hrtime_t gethrvtime(void);
```

Multiple High-Resolution Clocks

POSIX.4 real-time library (`-lrt`)

```
#include <time.h>
struct timespec tp, res;
if (clock_gettime(CLOCK_REALTIME, &tp) < 0) {
  perror("gettime");
}
clock_getres(CLOCK_REALTIME, &res);
printf("time %d.%09d\n", tp.tv_sec, tp.tv_nsec);
printf("res. %d.%09d\n", res.tv_sec, res.tv_nsec);
return 0;
```

Clock Synchronization

- `daytime` (RFC 867): character string, e.g., “Mon Sep 27 14:33:10 1999”
- `time` (RFC 868): binary; seconds since 1/1/1900.
-

adjtime

- need to adjust time, but . . .
- time can't move backwards (why?)
- shouldn't jump
- can't use absolute setting
- `adjtime(struct timeval *delta, struct timeval *old)`
- change speed by $< 1\%$
- used by network time synchronization algorithms

Network Time Synchronization

- primary receivers: GPS, LORAN-C
- local, unicast, multicast

```
ntpq> lpeers
remote        refid           st t when poll reach delay offset  disp
=====================================================================
LOCAL    LOCAL(0)         10 l   18   64   377  0.00    0.000 10.01
*cunixd ntp2.usno.navy.   2 u   27   64   377  2.08 125.253  0.75
+sirius NAVOBS1.MIT.EDU   2 u   34   64   377  2.33 118.975  1.80
+cs     sirius.ctr.colu   3 u   23   64   377  0.53 119.313  0.63
```

polled every 64 seconds